PHOTO-MECHANICAL PROCESSES.

W. T. WILKINSON

HAMPTON & CO.

PHOTO-MECHANICAL PROCESSES.

A PRACTICAL GUIDE TO

Photo-Zincography, Photo-Lithography, and Collotype.

BY

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PREFACE.

By re-writing Part III. and the addition of Part VI. and an Appendix, I have endeavoured to bring this, the Standard Handbook of Photo-Mechanical Processes, up-to-date. Whilst the Appendix was passing through the press, Mr. W. Gamble (of Penrose & Co.) published an article, which is practically the same as the one in the Appendix. This is a coincidence which is worth recording, although precedence must be given to Mr. Gamble. The paragraph on Poster Blocks was partly written at the end of July, but was not sent to the printers, because I wanted to make certain experiments in the method before doing so; and, these experiments proving satisfactory, the remainder was written on the 12th August, Mr. Gamble's article in *Process Work* reaching me on the 16th.

For the rest, nothing has been written that has not been thoroughly tested, so that this book can be classed as thoroughly practical from beginning to end.

There is on the market a book bearing my name, and dated 1894. This date is wrong, the book being merely a reprint of the one written in 1890.

W. T. WILKINSON.

PLATES.

A FLORAL BOA.

[Specimen of Photo-Chromic Printing from blocks lent by F. C. Clarkson, 4, Fenchurch Avenue, E.C.]

INTRODUCTION.

THE processes to be treated of in these pages will comprise Photo-Zincography, Photo-Lithography, and Collotype.

Photo-Zincography applies to the production of plates for letterpress printing; Photo-Lithography to the preparation by photographic means of transfers for the stone, from which the lithographic proofs are printed; Collotype being a process of preparing, photographically, the surface from which prints in greasy ink, with the smooth half-tones of an ordinary photograph can be made in a manner analagous to that by which an ordinary lithograph is printed.

In Collotype we obtain the photographic half-tone automatically, but in photo-zincography and photo-lithography we must either start with a drawing or an engraving, or we must break up the half-tones in such a manner that the pictures will print on the flat. In line work in either photo-zincography or photo-lithography, where the original is made in line, dot, or stipple, the transference of the photograph to a zinc plate to be subsequently etched into relief; or to a sheet of prepared paper for subsequent transfer to a polished stone; the work is comparitively easy and straightforward, but when photographic half-tone has to be dealt with, then quite a different method of procedure is necessary, as the half-tones must be broken up, or levelled up, to bring them to the same level as the blacks of the picture. This is done in photo-zincography by interposing a very fine network of lines, technically called a ruled screen, which practically converts the image into a line subject. In photo-lithography, the same method of breaking up the half-tones may be used; but the better method is to use an ordinary photographic negative,

and from this to make a print upon a specially-prepared film of bichromated gelatine, dried at a high temperature, the effect of which will be to cause the gelatine to pucker or reticulate, and this reticulation breaks up the half tones in such a way that the image is kept open and will print clean.

To produce a photo-zinco block a negative is made from the subject, from this negative a print is made upon a polished sheet of zinc in bichromated albumen, or in bitumen dissolved in benzole, or in chloroform. The image in bichromated albumen is coated with fatty ink before development of the exposed image, the ink clinging to the albumen that the light has acted upon and rendered insoluble, forming the groundwork upon which a sufficient resist can be built up to enable the etching away of the white portion of picture. When bitumen is used to make the print from, the portions not made insoluble by the action of the light are dissolved by turpentine, leaving the image on the metal, and forming the acid resist.

In photo-lithography the negative in line is exposed in contact with a sheet of paper prepared with bichromated gelatine (or albumen, gum-arabic, sugar or gum-tragacanth, &c.); this paper is subsequently inked over with a fatty ink, which, after immersion of the paper in water, clings to the lines forming the image, and is easily detached from the whites, where the light has not touched.

In half-tone photo-lithography a grained or net negative can be used to make the half-tone transfer on the same paper as is used for line work, or an ordinary negative is used and exposed in contact with a film of bichromated gelatine on a sheet of glass, and then, after washing away the bichromate and drying the film, it is again wetted and inked up with a leather roller and the transfer pulled upon an ordinary litho transfer-paper.

Each of these processes requires its own photographic negatives, and it is upon the quality, and suitability of the negative, that the main part of the results depend.

The negatives in photo-zincography, and in line photo-lithography are identical in quality (differing only in an optical detail), and are entirely different to those suitable for half tone photo-lithography, or for collotype; so in order to simplify matters we will divide the negatives into two classes, calling negatives for line work, such as are needed for photo-

zincography and for line photo-lithography, Class I., and half-tone negatives, suitable for collotype and half-tone photo-lithography (from reticulated gelatine), we will call Class II.

In Class I. the characteristics of a suitable negative are:

1. Absolute sharpness of definition *all over the image.*
2. The lines, dots, or stipple, forming the image, and its various gradations, must be represented by perfectly *clear* glass.
3. The whites of the original must be represented by as near opacity as is possible.

Negatives of this class are always reproductions from drawings, engravings, woodcuts, &c., but in the case of half-tone blocks, the lines on the screen used to break up the smooth half-tones of the photograph, must show quite as clear as the dot, or stipple, in a line negative.

In Class II. a totally different negative is required, in which there is neither total opacity in the lights, nor absolute clearness in the shadows, and in which the gradations of tone from high light to shadow is rendered with perfect smoothness; a good half-tone negative is brilliant without hardness, and soft without flatness.

To make a good photographic negative it is absolutely necessary that the proper apparatus be provided. For copying drawings, &c., in the studio, a long heavy camera, well and substantially built, and without any of the most modern improvements, fitted with a good rectilinear lens is necessary. (N.B.—Single lenses, and portrait—Petzval type—lenses being useless for the work.)

When it is necessary to do work out-of-doors, landscapes, houses, machinery, &c., the copying camera will not be available, as it is not intended for such work, therefore another class of instrument will be required—viz., one fitted with swing back and all modern improvements, strong and rigid when erected, and light and portable for transit to and fro.

The last camera is, in fact, what all ordinary cameras should be, to be perfect, and to enable the work to be done comfortably, and well; but such a camera, good as it may be, will not do good work as a copying camera, therefore, as in working photo-mechanical processes, the copying camera is of the most

importance; that must be got at any price first, and if any makeshift has to be done, let it be upon the least important branch.

Photographic negatives are made in various ways:—First of all in quality, convenience, and in cost comes the wet collodion process, which has its great drawback to many in that it requires more care, skill, and brains to work than the more modern process of making negatives upon gelatine dry plates, which can be purchased ready for use, and only require exposure and development, whilst in the wet collodion process, the operator starts with a clean glass plate, coats it with collodion, sensitises the film of collodion by immersion in a solution of nitrate of silver; after this it is placed in the dark slide, exposed in the camera, returned to the dark room, and the image is developed, and the negative at once finished.

For negatives for Class I. the wet collodion process is the best, and should always be used unless there are any very special reasons why a dry-plate process will be more convenient, but even then the ordinary dry plates in the market for portrait or landscape work cannot be used, as they are utterly and entirely useless for the purpose. Either a collodion dry plate, made in the bath, or by collodion emulsion, or, if the plate must be purchased, it must be one of a special make, such as Mawson's photo-mechanical plate, or any of those gelatine plates made for the production of lantern slides; but to try and use ordinary dry plates is time and money thrown away.

For negatives in Class II. the wet collodion process is not so overwhelmingly the best, but still on many points it holds its own; but the ordinary dry plates, as used for portrait and landscape work, can be used without any trouble ensuing, or fear as to the results, in fact, unless the operator has had plenty of practice at the wet plate process, it will be best to stick to dry plates for negatives for Class II.

Full particulars will be given of all the negative processes named, and an endeavour made to make this book complete in itself.

Part I.

PHOTO-ZINCOGRAPHY in Line and Half-Tone,

AND

PHOTO-LITHOGRAPHY in Line.

CHAPTER I.

THE WET COLLODION PROCESS FOR LINE NEGATIVES.

The operations necessary to make a wet collodion negative in line are as follow:

1. A sheet of glass is cleaned and coated with a very thin film of albumen, or it is polished with a chamois leather.
2. The clean sheet of glass is coated with collodion, a thin film being left thereon.
3. The collodionised plate is immersed in a solution of nitrate of silver, wherein the film is made sensitive to light, by the conversion of the bromide and iodide salts into bromo-iodide of silver.
4. The sensitive plate is put into the dark slide and exposed in the camera to the subject to be photographed.
5. The image is developed (being invisible) by flooding the plate with the iron developer, and when the image is properly developed, washing off the developer under the tap.
6. The bromo-iodide of silver not blackened by the light is dissolved by means of a solution of cyanide of potassium, and again well washed.
7. The image is bleached in a solution of nitrate of lead and ferricyanide potassium and well washed.
8. The image is blackened with a solution of sulphide ammonium, washed, cleared with a weak mixture of acid, again washed and put away to dry, which operation, if desired, can be hurried, in front of a fire.

The importance of thoroughly washing the plate between each operation after development has been effected, cannot be too strongly insisted upon, because, if any of the previous solution remains in the film, the application of the next will cause a stain, therefore the dark-room in which the negative is made must have a good water supply and be fitted with a sink to carry off the used water.

This dark room is not dark in the ordinary visual sense, but only in a chemical one—*i.e.*, although sufficient light is admitted to enable the various operations to be conducted in comfort, and with certainty, that light is of such a colour as to have no chemical effect upon the sensitive film. This end is attained by covering the window with three or four thicknesses of a yellow or orange fabric; or by glazing with yellow or orange glass; gas jets, or paraffin lamps, or electric lights, may be used as the illuminant, but must be screened with yellow or orange fabric.

The sink and water-tap must be fitted in front of the window, the room must be of sufficient size to allow of comfort in working, and kept entirely for negative work and not as a general store-room for all the rubbish of the establishment, collecting that arch-enemy to good negatives—dust; sufficient bench and shelf room are requisite, so that all bottles can be kept in their places, and the various operations conducted without fear of mixing one chemical solution with another.

The silver bath when in use must be as far away from the sink as possible to secure plenty of light, and yet be away from splashes; and where the bath is, the dark slide must be close to, and have sufficient room to allow of easily filling in the largest plate.

The dark-room must be kept at an equal temperature all the year round, not roasting hot in summer (as this causes a foggy bath), nor ice cold in winter as then the image is poor and dirty, a temperature as near 60° F. will ensure good negatives with a minimum of trouble.

The chemicals required for preparing for the wet collodion process comprise :

Collodion.
12 ounces nitrate silver.
1 ounce pure nitric acid in stoppered bottle.
7 lbs. sulphate of iron.

1 lb. acetic acid (glacial).
1 gallon methylated spirits of wine.
1 lb. cyanide of potassium.
1 lb. ferricyanide of potassium.
1 lb. nitrate of lead.
1 lb. sulphide of ammonium.
1 lb. commercial nitric acid.
2 wide-mouthed Winchester quart bottles, corked.
3 narrow ,, ,, ,, ,,
1 20-ounce stoppered bottle.
1 glass funnel, 10 inches diameter.
1 lb. best pure cotton wool.
1 10-ounce glass measure.
1 4-ounce glass measure.
1 20-ounce bottle, corked.
1 set scales and weights.
40 ounces alcohol.
40 ounces methylated ether (s.g. ·725).
2 ounces Hopkins & Williams' gun cotton, or
2 cakes Schering's cellodine.
2 ounces iodide of zinc.
2 ounces bromide of zinc.
1 ounce iodide calcium.
2 or 3 thin glass rods.

For the silver bath a holder will be required, either an upright bath with a dipper, or a large flat dish, but these will be treated of under the head of "Silver Bath."

Glass plates and cloths, &c., for cleaning same, will be mentioned separately.

Collodion.—Collodion is a solution of gun-cotton (or pyroxyline,) in a mixture of ether and alcohol, forming a thin viscous fluid; when first made, slightly opalescent, which disappears after standing a week or two, leaving the liquid clear. Collodion can only be cleared by standing, filtration not affecting the operation; therefore, as it works better when clear, the plain collodion should be made some time (say a month) before required. The plain collodion requires the addition of an iodide and bromide to make it fit for photographic purposes, and after these are added a few days' standing will be requisite to ripen it before use, as freshly-iodised collodion does not give good negatives.

Collodion can be purchased, and should be purchased if wanted in a hurry, and before home-made has had time to settle and ripen.

Mawson's collodion is sold in two solutions, the larger bottle containing the plain collodion, the smaller the iodiser; and these two are mixed three or four days before being required, in the proportion of one part of iodiser to three parts plain collodion.

When the iodiser and plain collodion are kept apart, they will "keep" in good condition for years, but, when mixed, deteriorate in about six months.

Collodion must be stored in a cool dry place. The alcohol and ether being very volatile would evaporate if kept in a hot place. To make 80 ounces of collodion, take a clean dry Winchester bottle with a close-fitting stopper, and put into it 500 grains of Hopkins & Williams' photographic gun-cotton; add 30 ounces of alcohol, and shake up well, then add 40 ounces of methylated ether (s.g. ·725), and shake until the cotton is all dissolved.

(Methylated alcohol cannot be used for collodion since the alterations in excise regulations, 1890).

This forms the plain collodion, and must be put away to clear, and when clear, must be carefully decanted, so as not to disturb the sediment at the bottom of the bottle.

The iodiser is made by dissolving in a clean bottle, in 10 ounces of alcohol,

Bromide of zinc	100 grains.
Iodide of zinc	200 grains.

And when dissolved filter through cotton wool.

When the plain collodion has cleared, carefully decant into another bottle, and add the iodiser as above, and it will be fit for use in a week, and will keep in good condition for a year.

Collodion may be iodised with other haloids, as well as zinc, but none of them give the same keeping power combined with density, the nearest approach to this iodiser (the plain collodion being the same) is

Ammonium iodide	240 grains.
Ammonium bromide	120 grains.
Alcohol	10 ounces.

Dissolve and filter.

Collodion iodised with this is ready for use in two days after iodising, but will be red, and yields thin images at the end of three months.

For coating plates provide three 10 or 20 ounce corked bottles, and fill them with collodion; use one of them during the day, in the evening fill up with fresh collodion, and put it at the other end of the row, using No. 2 next day, and filling this up as before; and next day using No. 3, so that each bottle will have two days' interval between using. Never use the collodion to the bottom of the bottle, but put it away when three-quarters of the contents are used, so that none of the dregs get on the plate and cause spots. Never shake up a bottle of collodion, as, no matter how old the fluid is, or how often it has been decanted, a sediment will form, and should not be disturbed.

The proportion of gun-cotton given to form the plain collodion may sometimes give too thick a solution, and yielding a lumpy film; in that case, add sufficient of a mixture of alcohol and ether (in equal parts) till it is reduced in thickness, and flows easily over the plate, leaving a smooth hard film. The reason of this precaution is that some cottons yield a more limpid solution than others do, with the same quantity of mixed solvents.

Absolute beginners should not make their own collodion, but purchase it, and then, when familiar with the commercial article, make their own.

Nitrate of Silver Bath.—This is a very important solution, and requires great care and cleanliness in its preparation and working. If taken care of, it will work well for many negatives, but, if carelessly used, it will stop at once.

The quantity of solution in use at a time must be approximate to the maximum size of plate used, and also to the quantity of plates passed through each day. Every collodionised plate sensitised in a solution of nitrate of silver takes away a certain quantity of the salt, leaving behind it an equivalent in nitrate of zinc, as well as ether and alcohol; and so long as these by-products are kept within their due proportions the solution will yield good negatives. But, if the proportion of silver salt is allowed to get low, then the by-products assert themselves, and the bath works badly. The larger the quantity of nitrate of silver solution in use, the longer will it work well, and this not in an approximate degree, but the reverse. Twelve ounces of nitrate of silver made up into a bath of one gallon

will yield more negatives, and of better quality, when worked in the bulk, than if the same quantity be split up into five or six separate baths, and each one worked till exhausted. And this is not very difficult to understand, when it is remembered that the abstraction of one grain of a salt from one hundred is the loss of one per cent., but taking away of a grain from a thousand reduces the loss to one-tenth as much. If the largest plate used is 15 × 12 inches, one gallon of solution should be in use; and, if larger plates still, two gallons will be none too much. The initial outlay may be more, but the subsequent gain is so great that the larger quantity is a great economy.

The nitrate of silver solution is used in two forms of vessel —viz., the old favourite narrow well into which the plate is lowered on a dipper, the vessel being preferably of glass enclosed in a wooden case, or sunk into a recess in the bench.

This form of bath-holder has many advantages; it takes up little room, and is so easily covered up that there is little chance of contamination from splashes, or from contact with the air, and any dust or dirt from the plates, or loose collodion film, can fall to the bottom and remain there, instead of settling upon the face of the plate during sensitising.

The dipper for lowering the plate is best made of wood, with either a cut-out ledge for the plate to rest upon, or a separate piece fixed upon it with wooden or silver pegs, any other metal being inadmissible. Such a dipper saturated with paraffin wax will last a life-time.

Another form of bath-holder is a flat dish of porcelain or papier-maché, three or four inches larger each way than the largest plate used. Such a bath-holder must be used in a remote corner of the room, and be fitted with a cover to prevent contamination of the solution, and to shield the plate from light during the process of sensitising. This form of holder takes up more room than a dipping bath, but is cheap, and, with care, quite as efficient. The solution should be returned to the bottle at the end of each day's work, or it will collect a scum, which will cause fog and spots.

For lifting the plate out of the bath, when sensitised, a silver hook is required, or a small ebonite lifter may be substituted, but no other metal or material is safe.

To make one gallon of nitrate of silver bath, dissolve 12 ounces of nitrate of silver (just the ordinary commercial) in 40 ounces of water, add 30 grains of calcium iodide previously dissolved in one ounce of water. Shake thoroughly, then add 120 ounces of water, filter into a clean bottle, add one dram of pure nitric acid, and put aside for a day or two before trying.

Filtration of the silver bath is best effected through cotton-wool, filtering papers being unsatisfactory. Always use a glass funnel for the silver bath, and keep it for the purpose only. Select a funnel with a wide stem, so that there is a good surface of cotton at the bottom. To charge a funnel for filtering, first thoroughly clean it, then take a pad of cotton-wool (cotton wadding will not do), and wet it thoroughly. Then throw the wet pad with some force into the bottom of funnel, when the pad of wool will be driven into the stem. Now drain as much of the water as possible from the wool, then proceed to filter, returning the first lot of solution filtered to the funnel, as it is usually slightly discoloured with the water.

The glass chimneys used for the common cheap form of the paraffin lamps make a very good filter; clean the glass thoroughly, tie a piece of clean muslin over the top, plug the top with a pad of wet cotton-wool and invert, putting the top down in the neck of a wide-mouthed bottle.

Always keep all funnels, bottles, dishes, &c., used for the silver bath, entirely for the purpose; never under any circumstances allow them to be used for anything else. A very good plan for wiping silver-bath bottles, funnels, &c., is to use a chamois leather damp, and reserve it for this purpose only. Everything depends upon keeping dirt out of the silver bath, and unless care is exercised this cannot be done. A silver bath is easily made, and, carefully used, is easily kept in good working order, but if allowed to get contaminated with organic matter its usefulness at once ceases. One of the commonest causes of trouble and of bad negatives is neglecting to keep up the normal strength of the solution, which is, of course, lowered each time a collodionised plate is sensitised therein.

Each ounce of collodion contains 1·5 grains of bromide and 2·5 of iodide, and will take up at least six grains of nitrate of silver in converting the haloids into silver bromo-iodide. In addition to this there is a certain amount of unavoidable waste, which

at a close computation will bring up the cost of sensitising each ounce of collodion to ten grains, and to keep up the working strength of the bath this waste should be replaced, which is best done by adding an equivalent of a saturated solution of silver nitrate. Or, to be quite exact, make up a solution of 240 grains of nitrate of silver in one ounce of water, then each fluid dram will contain 30 grains of the salt, and such an addition as this at the end of each day's work will go far to keep the bath in good condition for months. A time will, however, arrive when the quality of the negatives shows a great falling off, they being thin and dirty, and requiring a long exposure in the camera and an abnormal amount of alcohol in the developer to make it flow over the plate. This condition of affairs is caused by the fact that the by-products of the sensitising operation have become too powerful and require eliminating. In this case the best plan will be to take forty ounces of the old bath and pour it *into* one hundred and twenty ounces of water, then add sufficient of a saturated solution of carbonate of soda to make a piece of red litmus paper turn blue—*i.e.*, render the solution alkaline—then place the mixture in sun or daylight until a black deposit falls to the bottom of the bottle and the solution is bright and clear. Now filter carefully, add ten ounces of nitrate of silver; when dissolved add two drams of nitric acid; again filter and a new bath will be the result.

The remainder of the old bath should be evaporated to one fourth its bulk and then added to 100 ounces of water, and allowed to stand till required.

In the above directions it must be noticed that the used silver solution is poured into the water, and this point is very important, as by doing this we get rid of a lot of superfluous iodide, which, being soluble in a strong solution of nitrate of silver, would be kept in the solution should the water be added to the silver solution, but when the silver solution is added to the water, the water is in excess and the iodide is precipitated, and can be filtered out.

In evaporating the silver solution use either a porcelain evaporating basin, or a good enamelled iron dish, with either a water or a sand bath underneath, as it is not a good plan to allow the naked flame of the stove to play upon the evaporating dish.

Such a long description of the care necessary to manage a bath may be apt to frighten a beginner and cause him to imagine that the whole process is difficult and tedious, but such is not the case if the precautions are duly observed, a bath carefully made and kept up to strength will last a year or two, so that it is well worth while being careful, and, as forewarned is forearmed, nothing is lost by being clean and careful. The signs whereby the bath indicates that its working capacity is at an end, are first the inordinate amount of alcohol required in the developer to make it flow over the plate; secondly, the image is thin, flat and dirty, and refuses to intensify properly, the lines being dull instead of bright.

The Developing Solution.—This solution improves with age, so should be made up in bulk, and a stock always kept on hand. Make up two Winchester quarts (80 ounces each) at first, and when one bottle is exhausted refill it at once so that it can ripen whilst the other one is being used.

The formula for a Winchester is

Sulphate of iron	4	ounces
Acetic acid	3	ounces
Water	80	ounces
Spirits of wine	from 1 to 5	ounces

This last ingredient has no chemical action, its function being to cause the developer to assimilate with the film and flow smoothly over. When the silver bath is new, the spirit can be omitted altogether, but as soon as the developer refuses to flow evenly over the film, then spirit must be added at once, a small quantity at first, increasing the amount as the bath gets older, until five ounces are required, then the bath requires renovating. Never add more spirit to the developer than is sufficient to ensure an even flow over the plate.

Fixing or Clearing Solution.—After the image is developed, and the film has been well washed under the tap the lines of the image will look white on a reddish-grey ground, the white appearance of the lines being caused by bromo-iodide of silver that has not been discoloured or impressed by the light in the camera, and this must be removed before anything further can be done with the negative. This removal is called fixing (or clearing) and is effected by means of a solution of cyanide of potassium, or of hyposulphite of soda, both of

which salts dissolve the bromo-iodide of silver; cyanide of potassium is the best to use, but being a deadly poison and giving off unpleasant fumes is objected to by many operators on that account; it however gives so much better colour to the negative, acts so rapidly, and is got rid of so easily that its objectionable features are condoned.

Hyposulphite of soda requires at least ten times the amount of washing to get rid of and takes longer to clear the film. A plate cleared in cyanide solution can be washed and ready for intensification in two minutes, but one fixed in hyposulphite will take five minutes to clear, and at least ten minutes to wash.

Whichever of the two solutions are used, it should be kept in a dipping bath, one made of wood lined with thin sheet lead answers admirably, the dipper being of wood weighted with lead to overcome its buoyancy.

The formula for the solution of cyanide of potassium is

Cyanide of Potassium	3 ounces
Water	80 ounces

The exact strength is of no great consequence so long as it is sufficiently strong to act quickly (say within half a minute); if too weak it is apt to attack the image and make it thin. When after being in use some time cyanide should be added overnight, and in the morning a stir with the dipper will distribute the freshly-dissolved salt.

Hyposulphite of soda should be kept as near saturation point as possible; it does not attack the image, and the plate may be left in for any reasonable length of time without danger.

Intensifying Solutions.—The negative, after fixing, is too transparent (too thin is the usual photographic term) to allow a good print being made from it, because the light can get through those portions representing the whites of original almost as easily as it can through the lines. To obviate this the whites are intensified, that is they are made more opaque when looked through. This operation is effected in two stages; in the first the film is bleached, and in the second blackened.

The bleaching solution is made of

Ferricyanide of potassium	6 ounces
Nitrate of lead	4 ounces
Water	80 ounces

Care must be taken to get the ferricyanide or red prussiate of

potash *not* the ferrocyanide or yellow prussiate as the last will be useless.

The blackening solution is

Sulphide of ammonium	1 ounce
Water	3 ounces

A mixture of nitric acid one ounce, water 80 ounces is also required for clearing away a brown stain often left after blackening, caused by insufficient washing after bleaching, and before applying the sulphide solution. Hydrochloric or sulphuric acids may be used instead of nitric if preferred.

It may be as well here to mention that the above intensifier is only suitable for negatives in line, for photo-zincography and for photo-lithography and for wet collodion negatives, and that it cannot be used for gelatine negatives, grained negatives (wet collodion or on dry plates), or half-tone photo-zincography, or for half-tone subjects of any description. For these purposes other formulæ will be given in the proper place.

These comprise all chemical solutions necessary to produce a wet collodion negative, but before they can be used it will be necessary to provide some glass plates, and clean the surface.

The glass plates used for a wet collodion negative must be of the very best quality, waste glass that has been used for dry gelatine plates cannot be utilised, as it is of too poor a quality for this purpose, a good flattened crown is the best for ordinary line negatives, and that should be procured as it can be used over and over again. Glass plates for photographic use are cut to arbitrary sizes, viz.:

¼ plate	4¼ × 3¼
½ ,,	6½ × 4¾
1 ,,	8½ × 6½

After these come 9 × 7, 10 × 8, 12 × 10, 15 × 12, 18 × 15, 23 × 18, &c.

Before a glass plate can be collodionised it must be made chemically clean, or the dirt will reduce the silver upon and ruin the negative. There are two methods of cleaning a glass plate, one by polishing with chamois leather, the other by coating with a thin film of albumen.

For the first method provide a good soft chamois leather and wash it in cold water, to which has been added a little

liquor ammonia, until the whole of the whiting is removed; give a final rinse in clean water and hang up to dry; when dry the leather will be soft and free from fluff, &c. Some pieces of linen rag will also be required as well as a mixture of rouge in spirits of wine, and a flat board about 24 × 18 covered with a piece of smooth American leather, glazed side up; a plate laid upon this will not slip about during the operation of polishing.

Both sides of the plate must be thoroughly cleaned, and so must the edges, as one of the most prolific causes of derangement of the silver bath is organic matter introduced therein by imperfectly cleaned backs and edges of glass plates. One side of the glass plate, if gently rubbed with the thumb nail, will be found smoother than the other, and it is this side which is the most suitable for the support of the collodion film; smear both sides with the rouge mixture and polish off with the linen rag, then with the leather; polish until, upon breathing gently upon the plate the film of moisture is quite even and quite free from streaks, not only in the centre but at the sides as well. The golden rule in polishing a glass plate is to polish the sides, and the centre will polish itself. When the smooth side is polished (the back being polished previously) raise the plate on edge and examine and clean each edge in succession, then the plate is ready for the dark room.

Polishing glass plates must not be done in the dark room, or it will be impossible to get a negative free from dust. Negatives made upon dirty glass have a bright silvery appearance behind, are dirty and stained, and will split off in drying.

When the plate is quite clean an edging of indiarubber dissolved in benzole (the edging to be about the eighth of an inch wide) is run all round the margin of the plate on the polished face; a small camel's hair brush tied to a small stick, the end of stick and of brush being on a level, the stick then acts as a guard against the brush going too far from the edge. The indiarubber solution is used very thin and dries instantly; this edging is to prevent the film from slipping off the plate during the manipulations.

For line negatives the best method of cleaning the glass plates is the albumenising process, as then the film sticks much closer to the plate, and the operation of cleaning is not

such a tedious one as that of polishing, nor is any dust raised; polished plates cannot be done in advance, as they will not keep, but albumenised plates can be done in quantity, and stored for use, keeping any length of time.

First of all soak the plates in a dish containing nitric acid 5 ounces, water 80 ounces. Drop each plate in separately, and flat; if dropped in edgeways, they are liable to scratch those already in; allow the acid to act for an hour or two, then take each plate out separately, and laying it on a clean board, with a piece of coarse wet rag, or a small scrubbing brush, scrub the plate thoroughly, both sides and the four edges, and as each plate is thus cleaned drop it into a dish of clean water. When all the batch have been thus cleaned and put into clean water, prepare a solution of white of one egg in 20 ounces of water. Beat up the egg thoroughly, add 20 drops of liquor ammonia, then pour into the water; filter this through cotton wool, and fill up a glass measure with the filtered mixture; take a glass plate from the dish, rub it well on both sides with a clean wet rag, rinse under the tap, drain off the water, carefully examine both sides of the plate, and then flood the best side with the filtered albumen, throwing away what has been put on the plate; then put the plate on a rack to dry, and proceed to treat the whole of the batch in the same way. Be careful to put the sides that have been albumenised all facing one way, as there is nothing in the appearance of the film to show which is the right side. Stack the plates when dry on the shelf in dark room with the albumenised side next the wall. In pouring on the albumen from the glass measure, pour only sufficient to cover the surface of plate, allowing as little as possible to get behind. Glass plates that have been used, but not varnished, should be put into the acid water, which will speedily detach the old film. The plates are then scrubbed and dropped into the dish of clean water, and from thence are albumenised after a rinse under the tap. Negatives that are rejected before intensifying should be put into acid water at once, as allowing the film to dry upon the glass is not a good plan at all. Negatives that have been varnished are first immersed in a hot solution of washing soda, or in potash lye, the films being removed in these solutions. The plates are rubbed and rinsed, put into

the acid water, again rubbed and rinsed, then into clean water, and from this albumenised.

The old films removed from the glass plates must not be thrown away, but should be collected by occasionally filtering the acid water and soda, or potash lye, through an old felt hat, one being kept for each. When the hat is full of films it should be burnt, and the ashes sent to the refiner, with used filtering plugs, blotting paper, &c., that have been used for the silver bath, and have received the drainings from the sensitive plates. All are worth saving.

CHAPTER II.

MAKING THE NEGATIVE.

THE chemicals being all prepared, the next proceeding will be to arrange them in convenient position in the dark-room, as it is usually called, but which, as has been already explained, is merely a dark-room so far as the admission of actinic, or white light, is concerned—*i.e.*, the room must be so illuminated as to allow of all manipulation being conducted in comfort, and with precision; but the *colour* of the light must be such as will have no chemical effect upon the sensitive film of iodo-bromide of silver, formed in the film of collodion by immersion in the bath of nitrate of silver.

The amount of light, or area of dark-room window, cannot be too large, so long as the medium is of a safe yellow or orange colour. And if the room intended for a dark-room is provided with a window sash, cover the whole with three or four thicknesses of yellow or orange cloth, sold by photo dealers for the purpose. If a window has to be made, let it be three feet by two, and glazed with a good yellow glass; and then put in front of this one thickness of yellow cloth. Where the yellow or orange cloth cannot be procured, the yellow and orange printing paper, used by letterpress printers, will be a very good substitute; but the outside sheet will require frequent renewal, as the light fades the colour somewhat. Where the window faces the south an extra blind to pull down, when the sun is shining, should be provided.

The yellow or orange window must be the only source whence light is admitted into the room. All chinks or cracks admitting white light must be closed; the doors also must fit close, else the plate will be fogged. A good method of testing

a dark room window is to procure a few gelatine *lantern* plates, and having covered up the dark-room windows, fit one of these plates into a printing-frame behind an ordinary negative; and when the cover is removed from the window, let the printing-frame lay in front of the window, about two feet distant, for ten minutes. Then mix the developer, as directed upon the box containing the dry plates; place a developing dish handy, and re-cover the window. Then remove the plate from the printing-frame, put it into the developing dish, pour in the mixed developer, cover up the dish, and allow to stand five minutes. Then remove the plate from the dish, wash under the tap, and immerse in fixing solution of hypo-sulphite of soda, and, when fixed, examine the result. Then, if the plate is quite clear, the window is all right; but if there is the slightest trace of a picture upon it, the window is not safe, and will require another thickness of orange cloth or paper. This test is a very convenient one, and, if all the operations (except the exposure of printing frame to the full power of the coloured window), be conducted in absolute darkness, it is a conclusive one, but it must be distinctly understood that a slow gelatine dry plate labelled "for the production of lantern slides" must be used, and not an ordinary rapid dry plate suitable for portrait or landscape work, as the light suitable for such a plate would be far too opaque for collodion working. Such a test will enable a beginner to commence his collodion work in confidence and to know that if his plates show signs of fog, such fog arises from the bath, and not from his window.

The sink and water-tap should be in front of the window, the sink being of wood, lined with lead, and provided with a good outlet pipe. The dimensions of such a sink should not be less than two feet by eighteen inches, and nine or eleven inches deep, a shallow sink causing so much mess on the floor, from the water splashing over the sides. In the sink a small wooden stool is very handy, upon which the plate can be laid while being washed. The earthenware sinks now so much used are very good indeed; but being shallow, should be set low, and have a board in front flushed with lead to prevent the water splashing the operator and the floor.

The benches on each side of sink are used each for its

different solution, that on the left carrying the intensifying dish; on the right, close to the sink, the iron developer, the developing cup, and, a little back from the sink, the dish, or dipping bath, containing the solution of cyanide of potassium. When dishes are used each one should have a light cardboard cover to keep out dust and splashes of other chemicals; at right angles from the bench on the right, and as far away from the sink as possible, the silver bath should be placed, and between this bath and the front of the room the dark slide should stand, the various carriers not in use being hung on a nail so as to be handy when wanted. A shelf about three feet above this bench will hold the albumenised plates, face next the wall, and also the collodion bottles ready for use. Keep the dark-room free from anything else except just what appertains to negative making, and keep it clean, and half the troubles usually attendant upon working the wet process will be abolished. Provide one or two *clean* towels and renew them with as much punctuality as is generally deemed necessary in your bedroom. The door of the dark-room must be quite light tight, and be capable of being fastened on the inside, as nothing can be more annoying than having the door opened just when a plate is in your hands. All the care expended upon the fitting up of a dark-room properly will bear good fruit, in ease of working, and in certainty of result.

Everything being ready, we will now proceed to make a negative of a line drawing. First of all wash out the bath-holder and allow the water to drain away completely, then pour into it the silver solution, which has been previously filtered and is clear and bright—if at all muddy, and containing any floating particles, it will never produce clean negatives—put on the cover, then put the rest of the chemicals ready for use, wipe out the dark slide with a damp sponge, wiping the carriers also, and finally cut up some clean blotting paper into inch squares, and lay a large sheet of blotting paper upon the bench close to the bath, together with a pad about three inches by two, to be used for wiping the back of the plate before insertion into the slide.

To begin, attach a pneumatic holder to the back of an albumenised plate, and hold the plate in a horizontal position, dust with a broad camel's, or badger hair, brush (keep this brush always in one place, and never use, or allow it to be

used, for any other purpose than that of dusting clean glass plates). The pneumatic holder is in the left hand; with the right hand get hold of a collodion bottle, remove the stopper with the little finger and palm of the left hand, then in the centre of plate (which is held as near level as is possible) pour as much collodion as is deemed necessary to cover the plate all over (putting on more in preference to less); then gently incline the plate the right-hand furthest corner, then as the collodion reaches the corner, incline the plate gently, so that the collodion flows towards the furthest left-hand corner, and then continue it to the left-hand near corner, and from thence to the remaining corner, under which the collodion bottle, from which the collodion was poured, is held, and the surplus collodion allowed to drain into it. Whilst the collodion is draining into the bottle, keep the plate as horizontal as possible—consistently, of course, with allowing the flow to go on unchecked, and keep up a gentle swaying motion of the plate, to prevent the collodion from running in lines. When the collodion ceases to run, raise the plate from the horizontal, and when the collodion ceases to drip, return the stopper to the bottle, and the bottle itself to the shelf; hold the plate in a vertical position (diagonally) until the film at the lower corner has quite set, and is firm to the touch; then holding the plate by as little of the back surface as possible, detach the pneumatic holder from the back, and place the collodionised plate into the silver solution, previously closing the door of dark-room, as now, till the negative is fixed, no white light must reach it.

If the plate is held in the fingers for collodionising, the two first fingers of the left hand must hold the edges of the plate, the corner being clipped by as small a portion of the thumb as is possible. If the tips of the fingers are placed under the plate, the warmth from them will cause the collodion to set over them too quickly, and cause a marked film. Plates larger than $8\frac{1}{2} \times 6\frac{1}{2}$ cannot very well be held in the fingers, therefore a pneumatic holder is advisable.

If a dipping bath is used for the silver solution, remove the cover; raise the dipper till the ledge is about one inch from the top of bath holder, then place the plate upon the dipper, film side away from dipper; now lower the plate

gently until the dipper touches the bottom of bath, cover up, and leave for three minutes.

If a flat dish is used, after removing the cover, raise one end of dish with right hand, place one edge of the glass plate, which is held in the left hand, against the bottom of dish, then drop both dish and plate simultaneously, and the plate catching the wave of solution as it drops into it, will cause the solution to flow over in an even wave. The dish must be dropped gently so as not to splash the solution. The position of the plate and dish just before dropping will be represented by the letter V on its side, so ⊳.

With either dipping bath, or flat dish, the plate must be immersed without any hesitation, or a sharp line will be caused.

At the expiration of the three minutes remove the cover from the bath and raise the plate (in a flat dish the plate must be fished out with a silver or ebonite hook), and it will be seen that the appearance of the film has undergone considerable change, the transparency having given way to a semi-opaque opalescent appearance, this change being due to conversion of the iodide and bromide that were in the collodion, into iodo-bromide of silver by the nitrate of silver in the solution. This film is now sensitive to the light, and care must be taken that all white light is excluded from the dark-room. If the surface of the film shows any signs of a greasy appearance the plate must be gently raised and lowered a few times until this disappears and the surface is quite smooth. Now lift entirely out and let it drain until the solution no longer drips; then place one edge upon the blotting paper, and, holding the plate firmly by the top edge, wipe the back dry with the large pad of blotting paper. Next put the plate into the carrier of dark slide (the film being downwards and a small square of blotting paper having previously been put on each corner of carrier to take the final drippings), close the slide and carry it outside for exposure of the plate in the camera. It is very important not to omit to drain the plate well, and also the small pieces of blotting paper in the corners of carrier, as by these precautions the waste silver is recovered from the blotting paper, and the dark slide is kept from being rotted by the silver solution. The film on the glass plate is very tender, and care must be taken in handling

the plate so as to avoid damage. Be sure and do not touch the film in any way.

The operation of focussing the camera is generally performed whilst the plate is in the silver bath, so that the exposure can be made quickly; and whilst the plate is in its best condition. Place the dark slide into its place in the camera, and having seen that the lens is covered, draw out the front shutter, then remove the cap from the lens gently, so as not to cause the camera to tremble, make the exposure, replace the cap on lens, close the shutter of dark slide and return the slide to the dark-room, putting the slide in the place it was taken from. Now see that the developer is in the cup (a four-ounce glass measure makes a good developing cup), and that all the other chemicals are ready for use; open the dark slide and attach a pneumatic holder to the back of plate (not the holder used for collodionising, but another one, as each must be kept for its particular duty), and go to the sink, hold the plate in the left hand, in a horizontal position; take the developing cup in the right, and with the gentle sweep of the hand from left to right, cover the plate with developer.* Do this gently so as not to cause any of the solution to flow over the edges of the plate, but put on sufficient to cover the film completely, and in one wave, as if there is any hesitation in doing this the film will be marked. If the exposure has been about right, the image (hitherto quite invisible) will at once make its appearance, and as the plate is kept gently rocking to and fro, it will gradually gain in brightness—the lines white, the whites a reddish grey. Continue the development until all detail is out, but do not allow the action to continue. When the lines show any inclination to lose their whiteness, at once turn on the tap, put the plate on the stool underneath the tap, and wash until the water runs evenly over the film. When properly washed, place the plate into the fixing or clearing solution (cyanide of potassium) and allow it to remain until the whole of the white appearance on the lines is gone—*i.e.*, until the iodo-bromide of silver, not acted upon by the light during the exposure of plate in the camera, is dissolved by the cyanide of potassium. When the creamy white of the lines has disappeared, the lines will be

* Wet collodion plates cannot be developed in a dish.

bright and the rest of negative a yellowish grey. The plate is removed from the cyanide bath and well washed under the tap. Now take the negative into the daylight and hold it up so that it can be looked through. Examine carefully: first of all see that the image is perfectly sharp all over, if not, at once reject it; also reject it if there are any spots or stains upon it. If the lines are dull or veiled and the negative transparent it is bad. These veiled lines are caused by over exposure in the camera; unless the veil can be removed by gentle rubbing, then the bath requires the addition of a little nitric acid. If the lines are clear, but some of the finer details absent, and the negative generally thin and transparent, the exposure in the camera has been too short. Over exposure can be detected during development: when the image flashes out at once, and the lines veil over directly, it is a sign of such over exposure. Under exposure is indicated by the reluctant appearance of the image, and by the fact that, even with prolonged application of the developer, the detail in the dark portions will not come up.

Negatives rejected at this stage should be put into a dish of water at once, and not allowed to get dry, or the glass is injured and extra trouble involved.

When the negative is satisfactory it is well washed back and front, then drained, and at once immersed in intensifier No. 1 (nitrate of lead and ferricyanide of potassium). Here it speedily turns a light yellow, the time required for this varying with the solution. When quite new, one minute will be sufficiently long, but after being in use for a time, five or ten minutes will be required to obtain the necessary amount of bleaching. A little experience will, however, soon put an end to any uncertainty on this head. When properly bleached, the plate is washed until the yellow appearance gives way to a white, then the plate is held in the hand and flooded with a little of acid solution (nitric acid and water) No. 2, and again washed for half a minute; it is now flooded with solution No. 3, which will at once turn the film an intense black. Look at the back, and as soon as the film shows black behind, wash the plate, then give a final dose of the acid solution, which will clear the lines; again wash and put the negative away to dry. The acid solution must not be omitted, as its use prevents the formation of a brown stain on the lines, fatal to a

good line negative; plenty of washing is also absolutely necessary after bleaching, or the lines will be veiled beyond the power of the acid to remove. When the negative is semi-transparent, the cause may be either weak bath (generally accompanied by foggy lines or rotten lines), or the lead solution may be old and weak. In this case throw away and begin again.

A last word as to alleged difficulties in working the wet process. It must be remembered that the old wet process was mostly used for portrait and landscape work, in which the great *desiderati* were shortness of exposure and full range of half-tones; and, to secure these, the silver bath had to be worked as near neutrality as possible, and in that condition it was just on the verge of fog. And when, after a little working, this fog asserted itself, the addition of a little nitric acid and a rest soon restored the bath to a working condition. But the addition of the nitric acid, whilst not interfering very much with the quality of the negative, lengthened the exposure, and in time also affected the quality of the image; and it took all the skill and knowledge of the operator to keep the bath working at its highest sensitiveness, and, at the same time, keep up the quality of the negative. Now, in line negatives, we require neither extreme sensitiveness, nor any delicate half-tones; consequently we can use a sufficiency of acid in the bath solution as will keep the bath in good order for a long time, so long as we do not allow the normal strength of the silver nitrate to fall too low. If a nitrate of silver bath be made and worked exactly as directed in these pages, and kept clean and free from any contamination with organic matter, and the other chemicals made and worked also as directed, the wet-collodion process will be found quite as easy to work as any dry gelatine plate; and, as far as cost and quality is concerned, the dry plate cannot for a moment compete with it.

The method given above is for making negatives of subjects in line for photo-lithography and for photo-zincography, for each of which methods the same class of negative is requisite, in so far as the actual quality of negative and chemical manipulation are concerned. The only difference between a negative for photo-lithography and photo-zincography being in the position of the image upon the film, and this difference will be illustrated and fully dealt with in the proper place.

CHAPTER III.

LINE NEGATIVES ON DRY PLATES.

For line negatives suitable for photo-lithography or photo-zincography, or for the grained negatives for half-tone photo-zincography, the ordinary dry plates of commerce, used for portraits, or for landscapes, are utterly and entirely useless, they being made for quite antagonistic results; therefore, when from any circumstances, the operator wishes to use a commercial dry plate, instead of the wet collodion process, a special plate must be obtained, a plate such as that manufactured for the production of slides for the optical lantern being, with careful manipulation, capable of yielding very good line negatives. Mawson & Swan's photo-mechanical plates, Ilford special black-toned lantern plate (but not the Ilford Alpha plate) and Thomas's lantern plate are typical examples of suitable plates for the purpose.

The dark-room for working these plates will require a window covered with three or four thicknesses of orange calico, or of orange paper, and must be fitted with a sink and tap, as it is very important that the plate be well washed after each operation.

Dry plates are developed in dishes, and it will be economical to provide a dish for each size in general use, kept for the purpose of development only, and quite clean.

A large porcelain dish, a little larger than the largest plate in use, is also necessary, being required to hold a solution of hypo-sulphate of soda, for fixing or clearing the negative.

For development of negatives in line, either pyrogallic acid or hydrokinone can be used—hydrokinone for choice, as it yields

denser images, and is more free from stain than pyrogallic acid. When pyrogallic acid is employed, either the carbonate of potash or of soda should be the alkali selected, ammonia being liable to stain and varying so much in strength as to render its use unreliable.

The following formulæ have been used by the author, and can be recommended with every confidence:

HYDROKINONE DEVELOPER.

No. 1.—Hydrokinone	100	grains.
Meta bisulphite of potass	100	grains.
Potassium bromide	10	grains.
Water	20	ounces.

Sulphate of soda, 300 grains, may be used instead of the metabisulphite of potass.

No. 2.—Caustic potass (pure stick)	250	grains.
Water	20	ounces.

For a properly exposed plate equal parts of No. 1 and of No. 2 are used, mixed just before use (the mixed developer not keeping more than an hour), but the best plan is always to commence with half an ounce of No. 2 and one ounce of No. 1, and then add the remainder of No. 2, if requisite, and when it is found that the first mixture will not thoroughly develop the image.

ANOTHER HYDROKINONE DEVELOPER.

No. 1.—Hydrokinone	200	grains.
Sulphite of soda	2	ounces.
Citric acid	60	grains.
Bromide of potash	30	grains.
Water	20	ounces.
No. 2.—Carbonate of potass	2	ounces.
Carbonate of soda	2	ounces.
Water	20	ounces.

For properly exposed plates equal parts of No. 1 and of No. 2 are mixed just before use.

PYROGALLIC ACID DEVELOPER (STOCK BOTTLE PYROGALLIC ACID).

Sulphite of soda	4	ounces.
Citric acid	1	dram.
Water	8	ounces.

When dissolved pour into a one ounce bottle of pyrogallic

acid, and label "Stock Solution Pyrogallic Acid." This will keep any reasonable time.

DEVELOPER.

No. 1.—Stock pyrogallic acid	2 ounces.
Water	18 ounces.

This does not keep good more than a week.

Developer No. 2, saturated solution of carbonate of soda, for normal exposures take three parts of No. 1 and one part of No. 2.

An operator who develops a line negative on a gelatine plate is usually somewhat puzzled by the lines retaining their whiteness throughout the operation, but this is absolutely necessary, as if the lines veil over in the slightest the negative will be useless.

For fixing the negatives use a strong solution of hyposulphite of soda—about 8 ounces of hyposulphite of soda to 30 ounces of water—and use it clean and fresh.

Should any slight stain or veil be on the lines after fixing, flood for an instant (and wash quickly afterwards) with

CLEARING SOLUTION.

Cyanide of potass (pure)	60 grains.
Water	20 ounces.
Iodine dissolved in quarter of an ounce of alcohol	10 grains.

A GOOD INTENSIFIER.

No. 1.—Bichloride of mercury	1 ounce.
Chloride of ammonia	1 ounce.
Water	40 ounces.
No. 2.—Chloride of ammonia	1 ounce.
Water	15 ounces.
No. 3.—Sulphite of soda	2 ounces.
Water	15 ounces.

A negative that needs intensifying should be re-immersed in a fresh hypo bath, and allowed to remain there for at least a quarter of an hour, then thoroughly washed. Then clear with the clearing solution by just flooding it over; again wash, immerse in intensifier No. 1 until the film is white, wash for a few minutes, then flood with No. 2. Allow this to act for one minute, again wash, and flood with No. 3, which will instantly change the colour to a dense black. Again wash and dry.

Nos. 1 and 2 can be used till exhausted, but No. 3 must be used fresh for each plate.

To make a dry-plate negative, the box of plates is opened in the dark-room and a plate taken therefrom, the film side is dusted with a soft brush, then put into the dark slide, with the film side down, and the dark slide closed, the box of plates closed and put away. After exposure in the camera, return to the dark-room. See that the dish is clean, and that the developer is mixed; then close the door of dark-room, open the slide, remove the plate, and place it film side up in the developing dish. Pour into the dish the mixed developer, and see that the film is covered evenly all over. Rock the dish gently, and, if the exposure is all right, the image will make its appearance in about two minutes; but if there is any delay in doing so, the remainder of the No. 2 solution should be poured into the glass measure, the developer from the dish returned to the measure, and then the lot again flowed over the plate in the dish. This addition will, doubtless, cause the image to make its appearance, and, with continued rocking, it will gradually gain in brightness. The lines must retain their whiteness all through the development; if they veil over in the slightest, the negative will be quite useless. To attain the full amount of intensity, it will be requisite to continue the action of the developer a few minutes after all the detail is out, and this is quite important, as unless time be given for the developer to act properly, the negative, though clear in the lines, will lack sufficient density, and will require intensification, an operation that is best avoided when possible. When the negative is as dense as it is possible to get it, wash the plate well; then immerse in a dish containing the solution of hyposulphite of soda, in which the white appearance of the lines will be removed, and the negative cleared of the bromide of silver that has not been acted upon by the light in the camera. The plate should not be removed from the hypo solution directly it is cleared, but should be allowed to remain therein for at least three minutes longer, because there is always a certain amount of bromide of silver in the film that is quite invisible to the eye, and this must be dissolved by the hypo before the negative can be called properly fixed. This is a very important point when the negative has to be intensified, and is the reason why

a second and quite fresh hypo bath must be used when the negative is not sufficiently strong to print without being intensified. The negative being properly fixed, it must next be well washed, either under the tap, or in a grooved vessel, such as are sold by all photo dealers for such a purpose. The length of time necessary to eradicate the hypo solution from the film need not exceed fifteen minutes, at the end of which time the negative is immersed in a saturated solution of common alum for about one minute, and washed for another minute, and the negative put away to dry.

As negatives of line subjects for either photo-zincography, or for photo-lithography, are usually required in a hurry, and as a gelatine negative cannot be dried in front of a fire without melting the film, and so spoiling it, it will be necessary to proceed in a very cautious manner when about to dry a gelatine negative rapidly. First of all, blot off the water either with clean smooth blotting paper, or with old linen rag, quite free from fluff. Now immerse in a dish containing methylated spirits of wine, and allow it to remain there for two or three minutes. Then remove, and again blot off; and now, with a little waving about in the air, or placing in a current of warm air, the film will be quite dry in a minute or two.

CHAPTER IV.

COLLODION DRY PLATES.

Collodion dry plates are very easily prepared, and as they keep very well they can be prepared in quantity for future use. But the sensitiveness of a collodion dry plate varies from twenty times to about twice as slow as a wet collodion plate fresh from the bath. The process to be given here is one of the most rapid of the dry collodion (bath) plates, and, if due care is exercised in their preparation, they will be found to require very little more than three times the exposure of a wet plate, a difference that will be immaterial where only one or two plates a day are exposed. To make the difference of exposure better understood, we will suppose that with a wet plate a good negative can be obtained with an exposure of one minute. If one of these collodion dry plates be used instead of a wet collodion plate, the time of exposure will be three minutes, *and the result quite as good.*

Collodion dry plates can be prepared in the evening, but to do this it will be necessary to provide a suitable method of illuminating the dark-room, which can be managed either by putting a light outside the dark-room window, or by having a lantern inside. If this latter method be adopted, the best plan will be to procure a wooden box 24 inches high, 9 inches deep, and 18 inches wide, bore a few large holes in the bottom, and stand it upon legs about one inch high. These holes are to give air to the gas jet or small paraffin lamp used as the illuminant; a few holes in the top are also required for egress of air. When the gas jet, fed by a flexible rubber tube, or paraffin lamp is in position inside the box, cover the front with two thicknesses of yellow calico, or of paper, placing this lantern in such a position

as will illuminate the dark-room thoroughly. Provide two clean porcelain dishes filled with distilled water, and we are ready for work.

First of all the glass plates must be albumenised, as directed for the wet-collodion process. If they are polished an edging of indiarubber, dissolved in benzole, will be requisite to prevent the film slipping during development. Instead of coating with albumen after cleaning with nitric acid, followed by scrubbing, they are flooded with a solution made as follows:

Gelatine	100 grains
Water	80 ounces

Soak the gelatine in 40 ounces of cold water till it is quite soft, then add 40 ounces of boiling water, stir until the gelatine is dissolved, then add half-an-ounce of liquor ammonia, stir again to mix all together, then filter through cotton wool. The cleaned plate is drained, after washing under the tap, and held by one corner in the left hand, and flooded with the filtered gelatine, throwing the surplus away, afterwards placing the plate on a rack to dry, taking care that the coated sides of the plates are all faced one way. Plates coated with this gelatine solution will dry in an hour at the ordinary temperature of the dark-room, provided they are not placed too closely together upon the rack.

The collodion will work best with the addition of five drops of water to each pint, this addition being made twenty-four hours before required for use. Shake up well after the addition of the water, and put away to settle again.

Before preparing any plates, take a small glass plate, collodionise, and then sensitise it; when fully sensitised, remove from the bath (which must be at its *full strength* and filtered just before use) and let it drain for two minutes, then flood with iron developer, just as if it had been exposed in the camera, allowing the developer to act for about a minute, wash the plate under the tap, and fix in the cyanide bath. When fixed, wash, and if the film is perfectly clear (like clean glass) and free from any deposit, all is right for work, but if there is even the slightest deposit the bath must have a few drops of nitric acid added to it, be well stirred up, and allowed to stand three or four hours. Then another trial is made, and when the resulting plate is quite clean it is ready for work. Of course,

before attempting to make these dry plates it must be quite understood that some experience is necessary in ordinary wet-plate making, or else the instructions here given will be too advanced for a mere tyro, in fact such experience will be absolutely necessary to ensure success.

To make a dry-plate, the plates, already albumenised, or gelatinised, are coated with collodion, and sensitised in the usual way, giving at least five minutes in the silver bath to ensure a full conversion of the bromo-iodide salts into bromo-iodide of silver. When fully sensitised, remove the plate from the bath, and drain, then put into a dish containing distilled water, in which it remains until all signs of greasiness disappears; wash under the tap for a minute or two, drain off the water, and, holding the plate in the hand, flood with the preservative solution, putting on just sufficient to properly cover the film. Allow this to remain on for a short time, then throw away and again flood with some fresh solution, which, after being allowed to well permeate the film, is returned to the measure, to be used for the first flooding of the next plate. This being done, the plate is placed on a rack, and when all the batch have been prepared, the lot are placed in the drying-box, to be presently described.

The preservative solution is made as follows:

No. 1.—Boiling distilled water		10 ounces
	Coffee (pure)	1 ounce
	White sugar	200 grains
No. 2.—Distilled water		10 ounces
	Powdered gum arabic (white)	200 grains
	Powdered sugar candy	30 grains

Both solutions are filtered and then mixed.

This is called the coffee process, and is a very reliable one.

Another preservative is composed of

Albumen	1 ounce
Water	1 ounce
Ammonia	1 dram

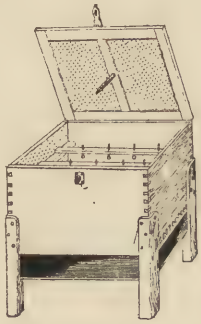
Beat into a froth, then allow to settle, and mix with an equal quantity of flat beer, or stout, just previous to being used. The excess poured on the plate is drained off, then the plate is washed under the tap for a minute or two, and finally coated with

Flat beer	1 ounce
Pyrogallic acid	2 grains

And put on the rack to drain. This is Capt. Abney's albumen beer process, and is an excellent one.

These prepared plates, after draining upon the rack, will require drying in a quick current of dry air; the quicker they are thoroughly dried the better will they keep.

A good form of drying-box, which is also used for drying photo-litho paper, is shown below.



The plates may be dried on the shelves in the dark-room, but they cannot be then relied upon for keeping quality, besides running the risk of fog from accidental light, so a drying closet is recommended. When the plates are quite dry they may be stored in light tight cardboard or metal boxes, with grooves, such boxes being obtainable at any photo dealers.

The exposure of these plates should not exceed five times that necessary to give a well-exposed wet collodion negative, but three times will be about the average. But, upon this point, a little experience will be the better guide.

For development, the ferrous oxalate developer is recommended, and it is very easily prepared, and always ready for use. It consists of two solutions, one of oxalate of potash, and the other of protosulphate of iron, as follows:

No. 1.—Oxalate of potash	1 lb.
Water (hot)	40 ounces
Bromide of potash	25 grains
No. 2.—Protosulphate of iron	½ lb.
Hot water	15 ounces
Sulphuric acid	10 drops

To develop a half-plate pour into a glass measure 12 drams of No. 1 solution (the oxalate) and add 2 drams of No. 2. Always mix these two solutions in this manner; never pour the oxalate into the iron, but *always vice versâ*, or the oxalate of iron will be precipitated as a yellow powder, and the developing action thereby destroyed.

Commence the development of the plate with the mixture; and if the image is very slow in making its appearance, add 2 drams more of No. 2, and again flood the plate. Should this fail to develop a good negative, the plate has been under-exposed, and another must be tried. If the image comes out quickly when the mixture is first poured over it, then the exposure has been too long, and the lines will be veiled. Use a clean dish for developing in, and allow the developer to act sufficiently long to obtain the density requisite for a good line negative. It is quite easy to get any amount of density if time be given for it.

When the development is complete, wash well, and fix in a strong solution of hypo-sulphite of soda; wash well after the hypo, and, if necessary, intensify in either the lead solution used for wet collodion plates, or with bichloride of mercury, as used for dry gelatine plates. Whichever is used, the negative must be thoroughly washed previously.

The hydrokinone, or pyrogallic developers given for gelatine dry plates, can also be used, instead of the ferrous oxalate, but the ferrous oxalate will give the cleanest and densest image.

CHAPTER V.

COLLODION EMULSION PROCESS.

In the dry collodion process, the film is sensitised in a solution of nitrate of silver, in order to convert the bromo-iodide salts into bromo-iodide of silver; but in an emulsion process the bath is dispensed with, the silver bromide being formed in the collodion, and when the plate is collodonised it is sensitive, and after washing away the by-products formed in the process of emulsification, it can be exposed wet, or made into a dry plate.

The manufacture of a collodion emulsion is not a very difficult matter, but it requires a good amount of care and precision, and if added to these there is a little elementary knowledge of chemistry, so far as relates to the atomic or combining proportions of the various haloid salts, then collodion emulsion making will be comparatively easy. The term "emulsion" means that the sensitive salt of silver in a very minute state of division, is held in suspension in a viscous body such as gelatine, or collodion. The bromide of silver is the best salt for this purpose; the admixture of either iodide or chloride not having any advantage over the simple bromide. There are two methods of emulsion-making; in one the emulsion is made up and used without any preliminary extraction of the by-product; in the other, after the emulsion is made, it is allowed to set, the by-products are washed away and the collodion re-dissolved. This last may be said to represent the acme of emulsion-making, and to require more skill and chemical knowledge than any advantage it has over the simple form of emulsion seems to render necessary, we shall therefore confine our work to the first—viz., the simple form of using

the emulsion and washing away the by-products after the plate is coated.

The gun-cotton for making the collodion is a very important item in emulsion-making. It should be short and powdery, and can be obtained from Hopkins & Williams, suitable for the purpose, or Schering's cellodine, sold in cakes, answers admirably.

In a 15-ounce bottle put 220 grains of bromide of zinc, add 2 ounces of pure alcohol (sp. gr. ·820), shake till the bromide is dissolved, then add 5 drops of pure hydrochloric acid. When this has been well shaken, add 100 grains of gun-cotton, and 5 ounces of methylated ether (·720), and shake until the cotton is dissolved. In a small glass mortar, powder 250 grains of nitrate of silver, add 1 dram of distilled water, and work this up with the pestle into a paste, then add three ounces of warm alcohol, and mix thoroughly (warm the alcohol by putting into a test tube, and putting this test tube into boiling water), then add slowly to the collodion, a little at a time, shaking the bottle vigorously after each addition. When all the dissolved silver has been added, wash the pestle and mortar with one ounce of alcohol, and pour this into the bottle, give the bottle a final shake, and put away for twenty-four hours to ripen. All this must be done in the dark-room, and, as a further precaution, encase the bottle with brown paper, as the emulsion is very sensitive to light.

The plates to be coated with this emulsion should be either gelatinised or albumenised, except it is intended to strip the negatives and have them flexible, then an edging of indiarubber dissolved in benzole must be given after polishing the plate with chamois leather.

Previous to coating the plate, the emulsion should be well shaken up, and then filtered, either through well-washed swansdown or through well-washed chamois leather (wash this in *cold* water, to which has been added liquor ammonia, followed by a rinse in clean water, giving a final rinse in alcohol). Tie the swansdown or chamois leather over the end of a small lamp glass that will fit into a wide-mouthed bottle, and whilst filtering, cover the top with a small glass plate to prevent undue evaporation of the ether and alcohol. Coat the plates with the sensitive emulsion, just as plates are usually coated with collodion, draining the

surplus into that being filtered, so that it is filtered before being used again. When the film of collodion has set thoroughly, immerse the plate in a dish of distilled water, in which it should remain until the greasy appearance is removed. It is then taken out and immersed in a dish containing flat beer, one pint, pyrogallic acid, 20 grains (filtered) for one minute, after which it is removed, and put on a rack to drain.

The first dish into which the plates are put, after collodionising, must be changed frequently, as it gets saturated with alcohol and ether, and with the by-products (nitrate of zinc, &c.), so that in a short time it ceases to do its work of clearing the film as it ought.

The plates are dried in a box, and when dried should be packed up, and kept from light and moisture.

These plates require an exposure very little over that of an ordinary wet collodion plate, and may be developed with either ferrous oxalate, or hydrokinone, or pyrogallic acid, the alkali used being either soda or potash carbonates, not ammonia.

CHAPTER VI.

A NEW COLLODION EMULSION.

THIS process is an original one, and is one that combines the clear lines of a wet collodion film, with the ultra sensitiveness of a gelatine emulsion plate; the emulsion is very easily prepared, and the collodion being kept entirely free from contact with the caustic nitrate of silver, flows better.

The whole of the operations must be conducted in the dark-room, and by orange light, and the plates, after drying, must also be manipulated in orange light, as they are more sensitive than a wet collodion plate.

To make 30 ounces of emulsion (which keeps well after making), dissolve in 10 ounces of clean water, 240 grains of bromide of zinc, 200 grains of bromide of strontium, and ½ dram of pure hydrochloric acid. Pour into a jar, add 100 grains of a good soft gelatine, and when the gelatine is quite soft, put the jar into a pan of cold water, and gradually raise the temperature of water in the pan to a boiling point, stirring the contents of jar until the gelatine is dissolved. Then (in the dark-room) add gradually, a solution of nitrate of silver, 600 grains in hot water, 2 ounces; stir with a glass rod, vigorously, during the gradual addition of the silver solution, and when all has been added, allow the water outside the jar to boil for fifteen minutes, then let the jar stand in the pan until the water is nearly cold; just before the emulsion gets cold or begins to set, pour in about a pint of a saturated solution of chloride of barium, stirring up all the time, let the lot stand in the dark for twenty-four hours. The addition of the chloride of barium will precipitate the bromide of silver, by destroying the viscous character of the gelatine, after standing for a few hours, when the bromide of silver has fallen to the bottom

of the jar, pour away the liquid, draining it as closely as possible, without letting any of the bromide escape ; next, fill up the jar with clean hot water, and stir up. Let the bromide settle again, then again pour away the liquid, and pour on more hot water ; stir, and allow the precipitate to settle ; pour this away, add another lot of hot water, stir up, let the precipitate settle and pour away once more. The object of these changes of water is to wash away the nitrates of zinc and strontium, also the chloride of barium and precipitated gelatine, &c.

Next add 10 ounces of alcohol, stir up, let the precipitate settle, pour this off, then add sufficient alcohol to make up the bulk to 15 ounces, add 240 grains of gun cotton (powdery), shake up well, then add 15 ounces of methylated ether, ·720, shake until the cotton is dissolved, and the collodion is ready for use.

Just before using the collodion, shake it up thoroughly, and filter through a piece of chamois skin, well washed in water and ammonia, then in clear water, and finally in alcohol. Tie the chamois skin on the end of small lamp glass that will fit into a wide-mouthed bottle, and when the collodion is in, cover up the top with a piece of glass to prevent undue evaporation.

Should this collodion be too thick, dilute with equal parts of alcohol and ether ; if too thin, add a few grains of gun cotton ; some samples of gun cotton yield a thicker collodion with a given quantity of solvents than others, so that it is quite impossible to give an *exact* formula for the quantity of gun cotton requisite.

The plates may be albumenised or gelatinised, or polished and edged with indiarubber, although it is not advisable to use the polished plates at all, except the resulting negative is intended for stripping ; in that case it is imperative that polished plates be used. The edging of indiarubber will prevent the film from slipping off. With plates albumenised or gelatinised there is no need of an indiarubber edging, because there is no tendency to slip at all.

Coat the plates with the filtrated emulsion in the usual way. If intended to be dried before exposure, dry in closed cupboard (see page 37), but they can be at once placed in dark slide and exposed wet. In the latter case it will be necessary to immerse in a dish of clean water before development, in order to get rid

of the ether and alcohol in the film, which would prevent even development.

Plates that are dried before exposure must be moistened with a mixture of ether and alcohol previous to application of the developer.

The developer may be *either* ferrous oxalate or hydrokinone, or pyrogallic acid, exactly as for any of the other dry-plate processes.

Extreme care must be taken that the light used in the dark-room during the emulsion is perfectly non-actinic, and also that the finished emulsion be kept away from light, or the whole bulk will be spoilt.

CHAPTER VII.

INTENSIFIERS.

For wet collodion negatives of line subjects nothing can compare with the lead and ferricyanide formula, but the odour of the sulphide of ammonium is to some people very objectionable indeed; in this case the following method answers very well: directly the yellow film has been washed away, leaving the negative a dull white, drain the plate, and flood with a solution of iodide of iron and permanganate of potash, and when the film is blackened, wash and clear with the nitric acid solution, and again wash. The iodide of iron solution is made of

Iron fillings	10 parts.
Iodine	5 ,,
Water	200 ,,
Permanganate of potash	5 ,,

or a saturated solution of permanganate of potash will give a good density, when the silver bath is in good condition, and the exposure of negatives is sufficient.

This method of intensifying is only applicable for wet collodion negatives and for line subjects, for dry plates (gelatine) or for half-tone subjects, it is not at all to be recommended.

ANOTHER INTENSIFIER.

No 1.—	Bichloride of mercury	240 grains.
	Chloride of ammonium	240 grains.
	Water	10 ounces.
No 2.—	Cyanide of Potassium	160 grains.
	Water	8 ounces.

dissolve, then add 120 grains of nitrate of silver previously dissolved in one ounce of water, shake well after adding the silver, and if the liquid is clear add a little more, until there is a slight precipitate of cyanide of silver left in the solution.

The negative, after fixing, is washed thoroughly, and is immersed in solution No. 1. until the film is quite white, then wash thoroughly, and immerse in No. 2, which will at once turn the negative an intense black.

This intensifier is especially suitable for negatives for half-tone photo-zincography, and also for the intensification of dry plates of line subjects, the lines being very clear and the opacity of the whites absolute, in dull weather and with poor originals. When using wet collodion, before fixing, a little intensification with pyrogallic acid and nitrate of silver can be resorted to without any fear of this intensifier clogging up the lines as the lead solution is apt to do.

BROMIDE OF COPPER INTENSIFIER.

A.—Potassium bromide	120 grains.
Water	4 ounces.
B.—Sulphate of Copper	240 grains.
Water	4 ounces.

The negative after fixing is well washed, then drained and flooded with a mixture of A and B in equal parts, until the film is bleached, then wash thoroughly and flood with a solution of nitrate of silver 30 grains, water one ounce, or with sulphide of ammonium, either of which will turn the film a dense black.

Negatives intensified with this must be varnished before printing from, else the film is apt to etch the zinc plate or to oxidise the bichromated paper.

Part II.

PHOTO-ZINCOGRAPHY IN LINE.

RIVER SCENE IN BOLTON WOODS.

[Made with a Levy Screen.]

Photo-Mechanical Process.

CHAPTER I.

INTRODUCTION.

In the general introduction mention is made of the necessity of having good apparatus for the production of photographic negatives, and it is impossible to attach too much importance to this fact, no matter whether it is used only occasionally or regularly, because the work can be got through with a smoothness that cannot be attained when makeshift appliances are used.

Do not try to combine the practice of out-door work with that of copying, as it is almost impossible to build a camera quite suitable for both purposes, in fact an attempt to do so would only result in a cost of more than for two sets of good apparatus, as well as entailing a lot of hard labour to do inferior work in both branches. For copying drawings, &c., indoors the camera used must be strong and heavy, as the slightest vibration during exposure, or variation from the focal point, is fatal to a good result. The bellows must be capable of extending to a little over twice the focal length of the lens, covering the largest plate that can be used in the camera; for instance for a plate 15 × 12 inches the lens should have a focal length of twenty inches, (equivalent focus, not back focus) and the camera must extend at least four feet to allow of a negative being made the same size as the original. The base board of the camera should be rigid, a folding or compound base board upsets at once the necessary rigidity. The best camera in the market for this purpose is fitted with two winch screws, one to move the front of camera to and fro, and one to move the back; both screws can be operated from either end of camera, the handle being detachable, and of a good size. The camera must be supported upon a very firm stand, the best form

being the box on small wheels, which should run either in grooves in the floor of studio, or upon rails set at exact right angles with the copying easel. Such a stand can be utilised as a cupboard in which to store odds and ends of apparatus when not in actual use.

Lens.—There is only one class of lens now made that is suitable for copying, that lens being the so-called Rapid Rectilinear, which in fact is suitable for all classes of work except quick portraits indoors. Portrait lenses (Petzval combination), single or wide angle lenses of any kind are not suitable for copying.

Negatives for photo-zincography (direct printing on the metal) must be reversed—*i.e.*, the position of the image on the negative must be correct as regards right and left, when looked at with the film next the face, an ordinary negative requiring to be viewed through the glass to see the image in its correct position.

To make these reversed negatives direct in the camera it is necessary to provide a mirror, fitted behind the lens, this mirror receiving the image as projected by the lens, and reflecting it upon the ground-glass, the result being that the image is correct as regards right and left.

When a camera is fitted with a mirror, it is not pointed straight at the subject, as is usual, but is placed sideways.

The Mirror.—This mirror is a piece of plate-glass, one side of which is ground perfectly plane, and this side is coated with a film of pure silver; this film being subsequently polished, will reflect the image from the lens without the slightest loss of light. It will be useless trying to work with an ordinary piece of plate glass, except in very rare cases, as unless the surface of glass carrying the reflecting film of silver be absolutely flat, the lines of the image must be distorted. The attempt to use an ordinary mirror with the back surface as the reflector, will result in the production of a double image. The size of the mirror must be sufficient to take the whole cone of rays from the lens, and as it is mounted diagonally at right angles, must be longer than it is high; for a lens, the diameter of which is 4 inches, a mirror 7 × 4 will be ample, The cost of a mirror, silvered ready for use, is usually about one shilling per square inch, and as with care the silver surface will last

for two or three years and can then be re-silvered at a cost of sixpence per square inch, it is not a costly piece of apparatus.

Mirror Box.—The base of the box should be made square, so that the lens can be turned downwards, a very useful position when copying out of a book, &c. The mirror must be very carefully managed to prevent tarnish and scratches; it should be taken out of the box when not in actual use, and after being carefully warmed in front of a fire, should be wrapped in a piece of fine silk velvet, also warmed, and put away in an air-tight tin case. If the surface gets tarnished, it can be easily repolished with a pad of fine dry chamois skin and dry rouge.

For copying drawings, &c., a sky-light or a studio will be required, but this need not be an elaborate affair, the only absolute requisite being that the easel or copying board upon which the drawings are fixed, shall be illuminated evenly all over, and whether this light is from above or the side is quite immaterial.

Studio.—In the studio there are several little articles required, which are very essential; a good sized cloth for covering the ground glass during the operation of focussing, and as a great aid to perfect sharpness, a small focussing eye-piece should be provided. The operation of focussing should be conducted carefully, using in the lens a medium stop or diaphragm say $\frac{F}{16}$, and getting the image sharp, about half-way between the centre and sides of screen; then for exposure use the smallest stop supplied with the lens; this, of course, will only apply when the largest plate the lens will cover is being prepared for. When smaller plates are being used, a larger stop will give the requisite degree of sharpness. A lens of twenty inches focus will give a good negative of a subject 3 × 2, as well as one 15 × 12, but a lens of say, 12 inches focus, will not cover a plate larger than 8 × 6.

Easel.—The easel, or board upon which the drawing, &c., is pinned for copying, must be perfectly parallel with the camera, both vertically and horizontally, and should have the centre marked, so that the drawings can be fixed at once in position, without having to consult the ground glass of the camera. A plentiful supply of stout pins (the common or domestic pin), will be useful to fix up the drawings, and if the drawing does not lie flat on the board a pin may be stuck in the paper in such a manner that it does not interfere with any of the lines, a broad

wash of gamboge or of Indian ink on the negative serving to prevent these pins showing on the metal.

The ground glass of the camera should have a vertical and a horizontal line drawn upon it in the middle of each dimension, each line being divided into inches and half inches from the centre where the two lines bisect, each inch being figured so that the operator can easily adjust the image to the required size. The centre of the ground glass should coincide exactly with the centre of the easel. A pair of large compasses, with a quadrant and screw to fix the legs at any desired distance apart, will also be a great help in getting the exact size of image on the ground glass.

CHAPTER II.

APPARATUS FOR PRINTING UPON ZINC.

THE articles necessary for printing upon the zinc plates are:—Polished sheets of zinc, gauge 17; pumice powder; fine emery cloth, No. 00; a cork rubber, as used by carpenters for holding glass paper when preparing woodwork for polishing; a board covered with American cloth, glazed side out; a wooden dish, about 24 inches, by 18 inches, by 6 inches deep, lined with pitch, and upon rockers; 1 lb. of fine cotton wool; a large spirit stove; a supply of methylated spirit for the stove; nitric acid (commercial); alum; an inking slab of litho stone or marble, about 15 × 12, or a sheet of zinc screwed at the corners upon a board; re-transfer ink, stone to stone, or litho printing ink; a bottle of turpentine, the cork of which is nicked, so that the turpentine can be sprinkled out; an ordinary type printers' roller, about eight or ten inches long, cast without a seam; a whirler; a well-made printing frame, box pattern, the bars of which are fitted with wooden screws, to give pressure, and the front a piece of half-inch plate glass; a small glass funnel; two 5 oz. glass bottles; two 10 oz. ditto; bichromate of ammonia or bichromate of potass.

Zinc Plates.—Zinc plates, suitable for photo engraving, must be of the best rolled metal. The Vieule Montague being the best brand, it is sold in sheets, or in cut sizes, planished, and polished ready for use. Various thicknesses can be obtained, but 17 to 15 gauge (B.W.G.) are quite thick enough for all practical purposes. It will be best to purchase it in large sheets, say 24 × 18, and cut it up as required, with either a circular saw, or a hand saw. Cutting up the metal with a small hand saw is not such a difficult operation as it may seem; once get a cut in, and the saw will go through almost as quickly as through hard wood.

The Polishing Board.—This is a very useful piece of apparatus, and is simply a flat board one inch thick, covered on one side with a piece of smooth American cloth, glazed side out. A plate laid upon this board can be polished without slipping about, as it does on the bench. The cost of this board is not much, but its value is great.

The Graining Tray.—This is a wooden tray, 24 inches long, 18 inches wide, and nine inches deep, lined with pitch, and can be made to do duty as an etching tray as well. It should either be suspended on pivots, or a stand, or be on a rocker, a good rocker being a piece of timber 4 × 4, screwed in centre of the bottom underneath, the lower side of timber being rounded at the edges then such a tray is easily set in motion ; two boards, each six inches wide (moveable), one for each end, will prevent the acid from splashing over while the tray is being rocked.

The Spirit Stove.—This is one of the small stoves sold for heating small kettles with a spirit flame; they are about four to six inches in diameter, and being provided with a cap to extinguish the flame when done with, are very handy. The iron supports for the kettle may either be cut off, or turned back, and made to do duty as a stand. Where an atmospheric gas stove is available, the spirit stove is not required.

Re-transfer Ink.—This is the ordinary re-transfer ink—stone to stone—as used in everyday-work by lithographic transferers, or Winstone's photo-litho transfer ink. Good stiff litho-printing ink is perhaps better than either of these, as where it is used the image is sufficiently strong to enable an operation of rolling-up to be dispensed with, the plate being ready for the etcher directly it leaves the printer on the metal.

The Roller.—This must have a good smooth surface, and be cast in a cylinderical mould without a seam; it may be on a litho stock, with projecting handles at each end, but one on a frame with a centre handle, as used by typographic printers, will be best. This roller should not be less than eight inches long and three inches in diameter; it should be of the best procurable composition, and neither too hard, nor too soft, especially the last, as if at all soft, it will drag and not ink up the zinc properly. Climate has a great deal to do with these rollers, as they are made of gelatine and glycerine, or sugar, or treacle, and a roller suitable for the climate of England will

not do for a hot climate; but this is always provided for by the manufacturer, if told for what place it is required.

The Whirler.—In order to get an even coating of albumen upon the zinc plate, it is essential that the plate be spun round with some velocity, so as to throw off the superfluous albumen by centrifugal force.

There have been many forms of whirler advocated at different periods; a flat disc, revolving on an upright spindle, the motive power being a handle and cog-wheels, or simply a piece of string, which, winding and unwinding round the spindle, sets the disc revolving first one way and then the other (and frequently damaging the knuckles of the operator). This shape of whirler is clumsy and expensive, is a source of annoyance in the matter of dust settling upon the coated plate, as well as distributing the surplus albumen all over the operator and the room.

The best form of whirler, that is cheap, handy, and effective, is the one here described; it has stood the test of time, and has not yet shown itself capable of improvement; it can be made at a cost of about three shillings, and when not wanted takes up little space. To make a whirler, get two pieces of wood, each ½ inch thick, twelve inches long, nine inches wide at one end, six inches wide at the other; upon the narrow end of one piece of wood fix with 4 screws, a piece of iron of the shape of a ⊥, the top end of which is square (a quarter of an inch square), the lower cross being flat, and pierced with four holes, each hole being countersunk; now place the two pieces of wood together, the iron ⊥ piece being between the two and hinge together with a pieee of stout leather. A strip of wood, about an inch from the wide ends, screwed on, will prevent the wood warping; four inches from the top (the hinge being the top) bore a hole right through both pieces of wood, and pass through a couple of stout leather boot laces (the two strands of leather are for strength, as a single lace will be liable to break quickly). *Leather* laces must be used, string or twine, or rope being useless, being without *stretch*. Fix one end of these laces on the outside of the piece of wood to which the iron ⊥ piece is screwed, and on the outside of the other piece seven inches from the top, hinge a piece of wood (so as to fall to-

wards the bottom end) four inches by two and a half inches, and in centre of batten, screwed on to prevent warping, fix a broad-headed nail or screw, over which the free end of the laces is passed. Then at a quarter of an inch from the bottom end of each cheek, drive in, and through, six or eight thin wire nails, each one inch long (the points projecting inside the cheeks, will prevent the plate from slipping forward during whirling) fix the square end of iron ⊥ into the socket of a common carpenter's brace, and the whirler is ready for use. The carpenter's brace must have the central handle loose, so that it will revolve, the ones that are fixed being of no use for this instrument, the screw which usually fixes the ordinary bit in the brace, as a rule, does not grip properly, so to make a good job of the affair it is advisable to file the iron ⊥ and let it pass right through the socket, and then rivet the end down. The brace recommended is the common one usually sold at one shilling, the better quality with compressing socket not answering quite so well.

The Sensitiser.—Either the bichromate of ammonia, or the bichromate of potash can be used to render the albumen sensitive to light; the ammonia salt is the most sensitive, and also has the advantage of giving a film that is not so liable to spontaneous insolubility in damp weather, the film also keeps longer; the potash salt is much cheaper and more readily obtainable, and, with the addition of a little liquor ammonia, has all the advantages of the ammonia salt, except in the matter of exposure; for summer weather the potash salt will meet all requirements, in winter and in damp weather the ammonia salt is best. In the formula given a saturated solution is named; this means that the water has dissolved as much of the salt as it can do. This method is very handy, because the addition can be made to the albumen so quickly. A more definite formula, giving the salts in grains, is here appended: White of one egg; put this into a bottle containing small pieces of broken glass, shake until the albumen is well broken up, add 10 ounces of water, shake up again, and add 45 grains of bichromate of potash or of bichromate of ammonia 60 grains in very fine powder (shake until this is dissolved).

The Printing Frame.—If the surfaces of the negative and of the zinc plate were absolutely flat, the mere laying of the

one upon the other would serve to get the desired contact between two; but as this perfect flatness is not possible in such work, means must be adopted to get the contact during exposure to light. For this reason the printing frame must be so made that screw pressure from behind can be applied, and so press the two surfaces into contact, but as the front of the frame must be transparent, and consequently must be of glass, this glass should be of sufficient substance to withstand the pressure requisite to bring the two surfaces in contact, and this pressure, given as it is, by means of screws, is so great, that the thicker the glass, the less chance of breakage. Glass less than half an inch thick, even for small frames (or below 12 + 10) should never be bought, as, although glass one inch thick is costly, still it is far cheaper in the end; it is also important, that the glass front of the frame does not at all fit tight.

CHAPTER III.

PRINTING ON ZINC IN ALBUMEN.

In order to get an image upon the zinc, it is coated with a solution of white of egg and bichromate of ammonia, or of soda, this film is dried over a flame; the plate is then put into a printing frame in contact with the negative, and exposed to light; the lines in the negative being transparent, the light renders the bichromated albumen insoluble in cold water. When the exposure is finished, the plate is covered with ink, the lines hold the ink and form the image, the whites washing away, because having been protected from the action of light by the dark portions of negative, the albumen underneath is still soluble in cold water.

A film of bichromated albumen when dry is very sensitive to the action of light, therefore the preparation of the plate must be done in a yellow light (gaslight will do), the window being covered with one thickness of yellow fabric or of paper.

The zinc plate is first polished with a wet rag dipped in fine pumice powder, or rotten stone, then washed and grained in a bath of

Water	80 ounces
Alum	1 dram
Nitric Acid	1 dram

The dish in which this is placed must be kept rocking until the polished surface of the zinc plate is destroyed, the surface of plate being a grey matt; then remove from the dish, wash well under the tap, rubbing the scum away with a pad of cotton wool, again rinse, and having laid the whirler on the bench, put the zinc plate between the two jaws (face outwards), tighten the laces first by untying them, and stretching as tight as possible, then by erecting the hinged piece on the top jaw; give

the plate another rinse under the tap, then whirl, reverse the whirler, holding the plate level, and coat with

White of one egg	
Water	10 ounces
Saturated solution bichromate of ammonia	1 ounce

Have a lot of small pieces of glass in the bottle, put in the white of egg and shake up well, add the water, then the bichromate of ammonia.

Two ounces of saturated solution of bichromate of potash may be used instead of bichromate of ammonia, but in this case 20 drops of *liquor ammoniæ* will also be required; a solution of bichromated albumen will keep in good condition for years.

The solution of bichromated albumen must be well filtered before use, and cotton wool is the best filtrant. Take a plug of cotton wool (surgical wool must be used, *not* cotton wadding), wet it, then throw it, with some force, into the neck of a glass funnel, and proceed to filter the albumen into a glass measure, and before coating the zinc plate, remove all air bubbles from the surface; coat the zinc plate in the whirler with the filtered albumen, and whirl, then let down the hinged piece, and release the plate; dry the film by holding the zinc plate (film up), over the flame of a spirit stove, or of a gas stove, moving the plate about until the film is dry.

When the film is dry it should be slightly shiny and quite even; if there are any wavy marks upon it there is too much bichromate in proportion to the white of egg. To remedy this, make up another egg, and only add half the quantity of bichromate to it, then add this to the other, and the result will be a good film. When a film does not dry properly on the zinc plate wash it off with water, and the plate is ready for re-coating. The albumen must be well filtered, or the film will be dirty and useless. Coat the plate in a room illuminated with yellow light, or by gas-light—as this has no effect upon the sensitive film. If done in daylight, the image will not develop properly.

The front glass of the printing-frame must be thoroughly clean, the back of the negative also. Place the film of albumen on the zinc plate, in contact with the film of negative, hold them tight so that they do not slip, then slide the negative along the front glass of the frame, and let the two plates drop into middle

of the frame, put in the back, and screw up tight, applying the pressure carefully, and evenly, then put the frame into the light for exposure. The time of exposure of a bichromated albumen film will vary with the strength of the light available. In bright summer weather, in direct sunlight, three minutes will be sufficient, but when the sun is lower in the heavens, five or six minutes will be required. In diffused daylight from five to ten times more is necessary, and when the negative is perfect, with clear lines, and opaque whites, great latitude is permissible, but if the whites are thin, or lines veiled, then the exposure must be hit to a nicety. (N.B.—With a good negative, 75 per cent. of all trouble is avoided, but with bad and indifferent negatives, there is any amount of trouble).

When the plate is exposed, the frame is brought into the work-room, and the plate removed. It is then rolled up with an ordinary typographic printing roller, charged with good lithographic printing ink, thinned with turpentine. The ink used must be good litho printing ink, quite stiff. Ink ready for the machine or press cannot be used. A little of this ink is put on the inking slab, and sprinkled with turpentine, the two are then worked up till thoroughly mixed to a consistence of thin cream; the roller is now passed through this ink, and the exposed plate, being laid face up on a clean sheet of paper, is rolled up, the roller being rolled to and fro until the turpentine has evaporated, leaving the film dry and thin. A good sign as to when the rolling is sufficient is when the plate adheres slightly to the roller. The film of ink upon the plate must not be too thick; if at all black, it must be sprinkled with turpentine and rolled again until dry.

This lithographic printing ink gives a cleaner and crisper image than the old method of using transfer ink, but the ink must be stiff and not thinned with varnish, as for printing.

When the plate is rolled up it is immersed in a dish of clean cold water, and rubbed gently under the water with a pad of cotton wool, when the ink on the whites will wash away, leaving the image in black on the metal. Remove it from the water, and clean out the ink from the finer lines, give a rinse under the tap, and put away to dry.

If the lines wash away during the development, the exposure has been too short; if the ink refuses to leave the whites,

and no picture can be developed, the exposure has been too long.

Plates that have been used require repolishing with the pumice powder, or rotten stone, re-graining in the acid bath, and re-coated with albumen.

The graining bath must be kept weak in acid ; if too strong the plate will be rough, and the block useless. A few drops of acid must be added whenever the action is slow, but too much must be avoided.

When the plate is dried after development it is smeared with gum solution, and again allowed to dry, when it will be ready for etching into relief.

For weak negatives the albumen solution may be diluted to fifteen or twenty ounces, the exposure in sunlight will then be reduced to from half a minute to one minute.

CHAPTER IV.

TRANSFERRING TO ZINC.

To make a relief block from a drawing made upon transfer paper, or from a transfer from stone, or from copper, the image is transferred to the zinc plate in a lithographic press.

As a rule, original drawings in line, or in chalk (on grained paper), are never transferred direct to zinc, but are first transferred to stone, and, when etched and made ready, re-transfers are made for transfer to zinc. This is done in order to guard against accident in etching the zinc plate, as, if the original is transferred to the zinc plate, and is spoilt in etching, then it must be re-drawn, entailing expense and delay; but when the original is put down on stone first, then, if an accident happens, another transfer can be made quickly.

Transferring to stone, as well as transferring to zinc, requires an intimate acquaintance with lithography, and can only be attempted successfully by an expert lithographer.

The zinc plate, to which it is desired to transfer the image, should be well polished, and grained in a bath of

Water	80 ounces
Alum	1 dram
Nitric acid	1 dram

The plate is immersed in this, and the dish rocked until the surface is a grey matt instead of being polished. Wash the plate well under the tap, removing the scum on the plate with cotton wool, then dip into hot water, and the plate will quickly dry after removal and be ready for transferring. When the image is transferred it should be rubbed up with litho-printing ink, dried, gummed up, again dried, and it is ready for etching.

CHAPTER V.

APPARATUS, &c., FOR LINE ETCHING.

For the process of etching a zinc block we require:

1. One or two good black lithographic rollers.
2. A glazed lithographic roller.
3. Soft etching ink.
4. Hard etching ink.
5. Lithographic printing ink.
6. Thin lithographic varnish.
7. Solution of gum arabic.
8. A hot plate.
9. An etching trough.
10. A pair of bellows.
11. Fine resin powder.
12. ,, asphaltum powder.
13. Two inking slabs.
14. Turpentine.
15. Nitric acid.
16. A flat brush.
17. A solution of shellac in spirits of wine.
18. Two or three sponges and a supply of clean rags.
19. A strong scrubbing brush, a strong solution of lye, paraffin oil, and sawdust.
20. Tools for cutting up the zinc, trimming and mounting the block.
21. Baywood for mounting the zinc plate on.
22. Strong palette knife.
23. Two pairs roller handles.

The Roller.—For rolling up, or reinforcing the ink on the ink on the block after each etch, a good lithographic roller is required, two such rollers would be better, keeping one for the first rolling up when lithographic ink is used, and one for the soft etching ink, which is much greasier and more difficult to scrape off.

The roller used is a leather lithographic roller for black ink, usually called a nap roller; the leather is stretched on a stock

covered with felt, the flesh side of the leather being outsile. When such a roller is bought new it requires a certain course of preparation before it can be brought into use. First of all it is warmed in front of a big fire and smeared all over with lard, rubbed in with the hand until the leather will absorb no more. When the lard has set the roller is scraped with a palette knife. To scrape a leather roller properly, before rubbing in the lard the leather is stroked with the hand, and when the set of the nap has been found—just as the nap of velvet sets—the handle towards which the nap sets is cut, and he roller is always scraped towards that cut, the handle with he cut upon it being always next the body, while the other handle rests against the inking slab on the bench, and the pressure of the body holds the roller tight. To scrape a roller the palette knife is held horizontally across the roller, both hands grasping the blade, the edge of the knife is then dragged from he bottom to the top, which action brings with it a length of lard (or ink), the knife is wiped on the left side of the porton scraped, which clears the knife and shifts the roller rount a little. When the knife is clogged with fat (or ink), it is wiped on waste paper. The roller being scraped, smear it with a little strong lithographic varnish and roll up on the slab. This varnish is very stiff and requires strength to get the roller over it at first, but patience will conquer; continue rolling up with this varnish (replenishing at intervals), at occasional spells, for two or three days, in order to clear out the dressing from he leather, and also to give stamina to the nap. Next scrape he roller, then roll up in soft etching ink thinned with thin litho varnish. Let the ink be quite thin at first, and gradually increase its consistency until quite stiff. This operation will extend over three or four days, at the end of which, again scrape, and the roller will be usable, though it will not work at its best for some little time.

If possible a good second hand roller should be purchased, but do not get one that is half worn out. To take a new roller and put it at once into ink is to utterly spoil it, and it will never work properly; a lithographic roller, well broken in and ready for use, is well worth ten shillings more than when quite new and untouched.

The Glazed Roller.—A glazed roller can be made from

a new roller, such as are sold for colour work, the grain of the leather being outside, instead of in as for a nap roller. Such a roller is first rolled up with lithographic printing ink until the leather has absorbed ink equally all over, it is then rolled up with a mixture of gold size and red lead mixed to a stiff smooth paste; this, when evenly rolled up, is allowed to get quite dry and hard, after which the surface is smoothed and polished with fine glass paper till it is level and smooth. If the first application of the gold size and red lead be not sufficient to obtain a smooth hard skin, another must be made. This roller must not be scraped, but may be cleansed with turpentine and a rag.

Soft Etching Ink.—Lithographic ink will give a good resist to the acid used in etching, but when it is required to form a cover for the sides of the lines after etching it will not run, no matter how much it may be heated; therefore, in order to protect the sides of the etched lines an ink must be provided which, when heated, will run.

The following formula gives a good etching ink:—In an iron saucepan melt six ounces of Russian tallow, and as soon as the crackling noise stops add five ounces of yellow beeswax, when this is melted add two ounces of asphaltum, stir until this is dissolved, then add one pound of lithographic printing ink, adding a little at a time, and stirring until each portion added is melted, finally add one pound of thin litho varnish; mix thoroughly and pour out into tins or jars. When cold this is ready for use.

Hard Etching Ink.—This is a hard varnish rather than an ink, and is used to protect the tops of the lines whilst the steps caused by the different deep etchings are removed by the acid bath.

This ink is composed of

Beeswax	½ ounce.
Resin	1½ ounces.
Litho printing ink	2 ounces.
Shoemaker's wax	2 ounces.

Melt together in a saucepan, stirring well until thoroughly mixed; then pour into a jar or tin, and when cold it is ready for use.

Lithographic Printing Ink.—This should be of good quality and stiff—*i.e.*, not mixed with varnish and ready for use on

machine or hand press, as in such condition it is too thin for etching purposes.

Thin Lithographic Varnish.—The medium used by lithographers for thinning their inks is called varnish, but is not a varnish as understood by photographers, carriage painters, etc., as it is really a burnt oil, the burning being resorted to in order to get rid of the fat. There are various degrees of consistency of these varnishes, viz.: strong, medium, and thin; but we are only concerned with the last (except a little strong, which is like birdlime, for occasional use in preparing a new roller) which is used to thin the ink, principally the soft etching ink, to working consistency. This varnish is to be purchased from any dealer in printing materials. Good varnish keeps any length of time, improving with age; bad varnish skins over and becomes greasy.

Solution of Gum Arabic.—A solution of gum arabic is essential to keep the ink from attaching itself to the bare zinc, and to confine itself to the lines only. It is made by dissolving good gum arabic in water, thereby making a thick mucilage. A good way of making it is to half fill a jar with gum, fill up with cold water, and put the jar in a warm corner, stirring at intervals until the solution is thick enough, strain into a clean jar, add a few drops of carbolic acid, and it is ready for use.

The Hot Plate.—For commercial work this is a necessity, and consists of a thick iron plate, with top planed level, mounted upon an iron framework, and heated by atmospheric burners fixed underneath; a plate 18 × 15 inches, half-an-inch thick, and about two feet high, makes a good hot plate, the heater being composed of three perforated pipes, each fitted with atmospheric orifice at base, all three being attached to the one gas supply. For occasional work a small iron tripod, upon which the plate is laid, and heated with an atmospheric blow-pipe arrangement, is very handy; or the plate may be held at one corner by a pair of pincers, and heated over a gas-stove. The hot plate arrangement is the most satisfactory one.

The Etching Trough.—The etching trough (or box, as it is generally called), must be much larger than the largest plate etched therein. To etch a zinc plate 12 × 10 inches, the etching trough should be at least 24 × 18 inches, and 9 inches deep; the reason for this being that unless the etching fluid

has plenty of room to wash over the plate each time, the operation of etching is very much prolonged, and proceeds unequally. This box, or trough, may be mounted upon rockers, but the best plan is to fit it in a frame, suspended by pivots in centre of box, longways, and attach to it a crank worked from one end by a wheel, much in the same way that small wheel pumps are worked. Where power is available, this crank can be connected with driving shaft, then the etching requires very little attention.

The etching trough should be made of good seasoned inch deal, the bottom tongued and grooved into the sides, the tongues being well smeared with paint before screwing up. It must be lined inside with stout canvas and pitch, well ironed down, the coat of pitch being at least a quarter of an inch thick; the outside of box being covered with two or three coats of good black varnish. For commercial work the box should measure 30 × 20 × 9 inches at least.

The Bellows.—An ordinary pair of domestic bellows are very handy, with which to dry the plate when wet with water or gum.

Inking Slab.—These may be of slate, marble, litho stones, or of thin zinc, screwed to a wooden slab. Two are recommended, but the worker can manage with one.

Shellac Varnish.—In order to protect the back of the plate during the etching operation, a good coat of varnish is required. Black varnish is sometimes recommended, but it does not dry so rapidly as is desirable, neither does it withstand the repeated heatings, but requires to be renewed each time after such heating; and, if this is not done at the right moment —(*i.e.*, before gumming up), the varnish is of no use. Shellac varnish dries quickly, resists the acid perfectly, and is easily made by half filling a wide-mouthed bottle with orange shellac, filling up with methylated spirits, stirring up the mixture occasionally. The varnish will be thick enough in a few hours, and if methylated spirits be added from time to time until the shellac is exhausted, it will always be ready. Keep the bottle well corked, and have a brush fitted in a hole in the centre of the cork.

Tools for Cutting up.—For amateur operations, zinc plates may be cut up with a hand-saw and smoothed with a file,

but, for commercial purposes, a circular saw will be necessary for economy and precision. A planing block and plane are also required in order to turn out the blocks square and smooth. The holes in the zinc plate through which the pins are driven to hold it upon the wooden block, may be drilled with a hand-drill, or punched with a fine sharp punch. The pins used generally have conical heads, the top being flat, and are known as stereotyper's pins, though they are also used by shoemakers. Ordinary flat-headed pins stand up too much to be useful. The wood used to mount the blocks upon is baywood, about ⅞ of an inch thick, this giving, as a rule, a block just under type high, which is far better than being over. The printer can easily bed up a block, but seldom has the means of reducing the thickness.

The rest of the articles require no special comment, but all are necessary, and cannot be dispensed with.

CHAPTER VI.

ETCHING IN LINE.

In Chapters III. and IV. two methods are given of obtaining the image upon the metal, and as these plates are left at the end of each chapter in an identical condition, no different treatment is required on the part of either of them during the process of etching. The ink upon the plates, as left at the end of Chapters III. and IV., is not sufficient in quantity to resist the action of the acid that will be used in etching, therefore the first step to be taken will be to reinforce that ink and obtain a capable resist.

Clean the slab and scrape the leather roller, then take some litho printing ink out of the tin with the palette knife, and mix it with some thin litho varnish, using the palette knife for the purpose. The ink is stiff to begin with, and requires plenty of patience to get it and the varnish thoroughly incorporated. When mixed the ink must still be stiff; if it runs off the knife when held up, it is too thin. When the ink is mixed gather it up from the slab and place it at the end, then take a little on the palette knife, smear it along the roller. Next roll up all over the slab until the ink is evenly distributed over the roller and the slab as well. This operation takes some little time, and must be done properly. Then having washed the dried on gum from the plate, lay it face up on the bench, and proceed to roll up with the charged roller. Keep the plate well covered with moisture so as to prevent the ink taking on the whites, and continue the rolling until the image has taken as much ink as it possibly can. If the roller is too heavily charged, or the ink is too thin, the lines will get ragged, so care must be taken to guard against this: the water on the plate will make the surface of the roller glazed; when this happens

the roller must be passed over the slab until the surface is clear again; roll up the plate slowly, and with moderate pressure, heavy pressure and slow motion feeds the work; light pressure and quick motion takes off ink. Roll deliberately, and at frequent intervals re-wet the plate, and re-roll the roller over the slab. When the image has taken as much ink as possible, dust it over with some finely powdered asphaltium, brushing the powder well into the ink with a flat brush (of hog-hair). When this has been done wash the plate under the tap, and with a soft sponge wipe away all asphaltum powder from the whites, wipe off all water, and dab dry with a soft cloth,

Now prepare a bath of

Water	1 quart.
Nitric acid	½ ounce.

Immerse the plate in this, and rock the tray for half a minute. Remove, wash under the tap, wiping with a sponge, dab dry with a soft cloth, then put it on the hot plate until the ink is melted, then remove and allow to cool. Just before the plate is cold, stand it against the wall (face inwards), and paint over the back with shellac varnish (this dries at once), then paint over the margin of the picture in front, taking the varnish to within a quarter inch of the picture. When this is dry carefully examine the picture, and if any lines are broken, or any additions have to be made, they must now be attended to, a little hard etching ink thinned down with turpentine, and a good sable brush being used for this purpose.

The plate is now ready for the first etch, but if it were etched at this stage we could not get any further, because we should not be able to protect the sides of the lines that the etching had made bare. So, before etching, it is necessary to again roll up the plate, this time using soft etching ink. Therefore, after touching up the plate (if needed), it must be smeared over with gum and allowed to dry. Whilst the gum is drying scrape the roller, and charge it with soft etching ink, then wash off the gum and roll up the image with this ink. Keep the plate moist and roll carefully so as to get as much of the soft etching ink on the image as possible, but without in any way allowing it to touch the zinc outside the lines. If the lines are at all ragged, the soft etching ink is either too thin, or the roller is charged too heavily. Keep

the plate moist, and as the roller glazes a little on account of this moisture, re-roll over the slab until the glaze disappears, then return to the zinc. As soon as the image has taken as much ink as possible, dust the plate over with fine rosin powder, brushing the powder well into the ink, then wash away the superfluous rosin from the whites, and the plate is ready for the first etch.

The etching trough must have sufficient water in it to cover the bottom about a quarter of an inch deep, to this is added sufficient nitric acid to make the water taste tart; the plate is now immersed, and the trough set rocking until the lines are standing up from the whites of zinc, about the thickness of a visiting card. The acid must be sufficiently strong to cause small gas bubbles to form upon the surface of the zinc, unless the solution be kept in motion, but not so strong as to cause these bubbles to form in spite of the rocking; as the etching progresses the acid will get weaker, and more must be added, but this is seldom required unless a large surface of zinc is etched in a small trough, then constant attention is required, and the work does not progress very satisfactorily. During the progress of etching, a little of the solution poured on the plate from a height will clear the scum away from the metal, then directly the rocking covers the plate again, if the zinc darkens, the acid is present in sufficient strength, but if the metal still retains the lighter colour, then the acid is not strong enough, and more must be added. Commercial nitric acid varies so much in strength that it is not possible to give exact quantities, unless the etcher possesses an hydrometer and knows how to use it, and even then the operation of testing would be far too complicated to be at all useful, wasting more time than would be necessary to get the plate etched. The best guide will be careful attention and subsequent application of the knowledge gained. Keep the acid sufficiently strong to give a vigorous bite but not so strong as to cause the gas bubbles to form in spite of the rocking given to the etching trough. In this lies the whole secret of etching a zinc plate. If the acid is too weak the process is not only slow, but there is far more danger of undercutting the fine lines, therefore, the work will progress more satisfactorily all round when the acid is kept up to its full strength, but the plate must be very carefully watched, as

upon this, the first etch, the whole quality of the block depends. The depth of the first etch should be about the thickness of a visiting card, but here judgment must be used, a block of a diagram with very broad whites and a few lines, will require a little different treatment to a block in which there are few whites, or to a block for a newspaper. Each class of subject must be treated in such a manner as to get the best results from each. Feeling the edge of the plate at the margin will give a correct idea as to the progress made, and constant examination of the plate will show if there is any danger of undercutting the finer lines. When it is judged that the etching has proceeded far enough, the plate is removed, washed under the tap, rubbed gently with a soft sponge to remove the oxide, and *dabbed* dry with a soft cloth. Do not rub, or the ink may smear and cause trouble afterwards. Examine the plate closely, first to see if the work is intact. If any of the lines are seriously interfered with, the whole plate is spoilt; if some are only slightly touched they may perhaps be strengthened with a brush charged with hard etching ink, thinned with turpentine till it will flow easily from the brush. The lines being intact, it must next be determined whether the depth is quite sufficient, if not, the plate must be returned to the etching trough for a little longer. The first etch is the most important stage of the whole process, and unless this is sufficiently deep, and is managed without encroaching on any of the lines, the plate will not be good. First of all use the acid of sufficient strength to bite the plate well, but not too strong to cause gas bubbles to form and stick to the metal, in spite of the rocking motion of the tray; have sufficient depth of liquid—but no more—to just cover the surface of plate, and, above all, do not attempt to etch in a small dish, or to put too many plates in the tray at once.

The first etch being satisfactory, the plate is put upon the hot plate, a piece of clean brown paper being placed underneath. As the heat of the plate will cause the zinc to curl upwards, provide a couple of bradawls and force the corners down alternately, so that the plate may be heated evenly all over. The effect of the hot plate will be to cause the etching ink to melt and run down the sides of the lines. The colouring matter in the ink runs but slightly, the greasy ingredients being

those most easily melted; therefore, to the unpractised eye, the full effect cannot be at once seen. When sufficiently run the plate is taken from the hot plate and allowed to cool, and is next smeared with the acid gum, which will at once show exactly how far the grease in the soft etching ink has run down. The metal when bare assumes a bluish tint, but when the grease has run down the acid cannot get at the metal, and it remains white. Careful observation of this will show exactly how far the sides of the lines have been protected. Allow the coating of gum to dry, then moisten, and roll up with the leather roller charged with soft etching ink, roll the plate first one way and then another—keeping it well moistened during the operation—until, by examination, it can be seen that the sides of the etched lines are quite covered. In the case of very close lines the image will be quite obliterated, the grease having spread entire from line to base. This is all right, as such close work is quite sufficiently deep by the first etch. When properly inked up all over, dust with powdered resin, rubbing this well into the ink with the brush. Wash off the superfluous ink, and, after strengthening the acid in the etching trough, put in the plate and proceed with the second etch. The image is now, or should be, perfectly protected from the action of the acid, therefore this etch does not require the same close attention that the first etch did. Keep the acid well up to strength, and the etching trough in constant motion, until the depth is double that given in the first etch. The time occupied by the second etch will rarely exceed twenty minutes if the acid is kept well up to maximum strength—*i.e.*, just short of causing gas bubbles too obstinate to be dispersed by the rocking motion of the tray—and the etching tray kept in constant motion. When the second etch is completed the plate is washed under the tap, rubbed with the sponge to remove the oxide, dabbed dry with a soft cloth, then put upon the hot plate until the ink is again melted and run down the sides of the lines. The plate is next cooled, smeared over with gum; then the roller dried, moistened; after which the plate is again rolled up with the leather roller, charged with soft etching ink, the ink, this time, being used a little thinner and with more on the roller. Keep the plate moist and use plenty of pressure upon the roller so that the ink can reach the

lowest depths, dust over with powdered asphalt, carefully examine the varnish at back of plate, and if it has been disturbed or abraided apply some fresh. Let this dry, then proceed with the last etch. This time the acid can be used stronger because all the work is now, or ought to be, thoroughly well protected, so that the etching can now proceed as rapidly as may be desired, and the acid kept to a good biting strength.

When the third etch has been taken as deep as it is desired the finished plate to be, the plate is washed and then the whole of the ink is cleaned off, first with paraffin then with lye. A handful of sawdust is good for cleaning off the plate.

Now the plate is deep enough and cleaned off; still it is not quite ready for printing from, because the successive steps, or ledges, left by each etch, would be apt to catch the printing rollers, and would eventually give a dirty print. To obviate this, the plate requires clean etching, for which purpose the glazed roller is used to coat the tops of the lines with the hard etching ink. This glazed roller should be kept coated with the ink ready for use, as the ink cannot be used wet, and it takes a little time to get dry.

To charge a glazed roller, wipe it quite dry with a rag and a little turpentine, take a piece of hard etching ink out of the tin, put it on the inking slab, sprinkle with turpentine, and with the palette-knife mix the two thoroughly until the ink is about the consistency of treacle. Roll the glazed roller in this until it has upon it a thin even coating, continue the rolling until the ink is almost dry, then put away the roller till wanted.

For clean etching, put the cleaned plate on the hot plate (with a large piece of clean paper under it), and as soon as it is warm, pass the glazed roller (charged with ink, as above) over it, the ink on the roller will adhere to the tops of the lines, and will give a resist to acid, take the plate off the hot plate, and place on the bench, continue the rolling up here until the plate shows a tendency to stick to the roller; take the plate, and carefully examine all the lines, in case any minute spot may have escaped being touched by the ink on the roller. If such is the case, it must be touched up with a brush charged with hard etching ink, thinned down with turpentine. This must be carefully attended to, or some of the lines may be

honey-combed, and the effect spoilt. After the plate is rolled up, and examined, the back must be coated with varnish, also the margin. When this is dry, it is ready for the acid. Empty the solution out of the etching tray, put in some more water, add sufficient acid to taste sharp, then immerse the plate, and start the etching trough rocking, and continue it until the edges of the steps are smoothed down. A good plan of ascertaining the biting power of the solution, is to make a slight scratch in the varnish on the margin, and every now and again to feel this with the finger-nail to see if the depth is increasing or not. Great care must be taken that the picture is not injured during this etching, constant watching, to prevent this, being necessary.

Allow about three minutes immersion in this bath, then withdraw, wash, remove the ink with paraffin, followed by lye, scrubbing with a strong brush. Wipe it dry, then examine, and if not sufficiently smooth, repeat the operation of warming, inking up, and re-etching.

The acid solution used for this clean etching can be kept and used for first etching of fresh plates, but acid used for first etching is not suitable for clean etching.

Mounting the Plate.—The margin must be cut away before mounting upon the wood block. This can best be done by means of a circular saw, but in the absence of this, a small hand saw, or fret saw may be used. After sawing away the margin, the rough edges are removed with a file, holes are pierced with a drill in the edges, and in the centres of the broadest whites, take a piece of bay wood about ⅞ of an inch thick, and with stereotypers pins, nail the trimmed zinc down to the wood. When this is done, with a chisel and mallet cut out the broad whites right through to the wood, and if the whites are very broad, scoop out the wood also. By cutting the metal after nailing on the wood, it is driven into the wood, and prevented from curling up. Next cut the block out, and with a shooting plane square the sides, and then, if the picture does not come close up to the edge, bevel the edges downwards.

Part III.

PHOTO-ZINCOGRAPHY IN HALF-TONE.

VIEW OF PART OF BOLTON ABBEY.

[Made with a Levy Screen upon an ordinary Gem Dry Plate, developed with Pyro Soda.]

CHAPTER I.

THE SCREEN.

The Screen.—The introduction of the Levy Screen for the production of grained negatives has put an end to home-made articles. These screens can be obtained of any desired size and of a number of grades of ruling (from 55 lines to 200 lines to the inch); but for ordinary practical use nothing coarser than 85 lines or finer than 175 are required. A screen ruled with 85 lines is suitable for printing from on a fast rotary newspaper machine, 100 lines for fast flat printing on coarse paper, 120 to 125 for average work, 133 for finer printing, and 150 to 175 for art printing. In a large establishment it will be necessary to keep all the above grades, but for a small user choice may be made of either 125 or 133. Whilst on this topic it may be mentioned that a Wolfe screen is quite capable of doing as good work as a Levy. Screens, especially when of a decent size, are very expensive, and consequently ought to be taken great care of. They must be kept perfectly clean, and to do this the screens should be polished with "papier Joseph" and a little spirits of wine. The slightest scratch on the surface is sufficient to ruin a screen, so great care must be taken in the cleaning operation. To avoid scratching, when not in use, the screens should be kept wrapped up in velvet, new washleather, or a silk handkerchief.

Screen Gear.—The screen, being a rather bulky affair, necessitates the use of various methods for fixing it in position in front of the sensitive plate. The best method is that illustrated in Fig. A, which shows the screen gear fitted in the body of the camera, and is so arranged that it allows of the withdrawal or advancement of the screen, rendered necessary by the shutter of dark slide. The handle at side, as shown, is used to

move the screen after the operation of focussing has been done, and again to replace the screen close to the sensitive plate after the insertion of dark slide and withdrawal of shutter, the proper position for the screen being shown by an indicator outside.

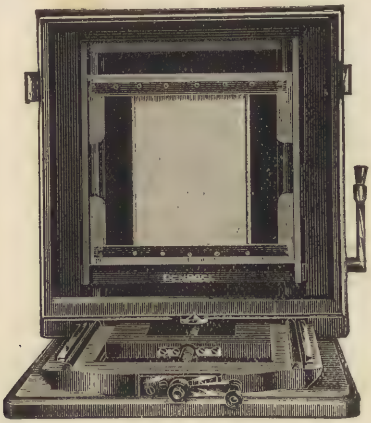


FIG. A.—SCREEN ADJUSTMENT GEAR.

A camera fitted as above is as near perfection as can be desired; the necessary adjustments are speedily made, and the screen being fixed in the camera does not incur any risk of being broken or scratched as does a screen carried in a dark slide. In fact, where a screen over 12 × 10 is used no other method than this ought to be tolerated.

When a dark slide is used there can be nothing better recommended than the new patent slide just introduced by Messrs. Penrose (Fig. B & C). The focussing is done in the slide, a ground glass frame being provided to fit in the same plane as the sensitive plate, and the centre of the ground glass has a clear 1-inch square for focussing with a microscope, thus enabling the adjustment of the screen and the focussing of the dot being done accurately and easily. (See Fig. C.) A dark slide of this description can be adapted to fit any camera otherwise suitable for copying.

Whilst it is an undoubted convenience and advantage to

have an adjustable screen gear, still it is not an absolute necessity; therefore, if the student is in possession of a dark slide with sufficient space in front of the sensitive plate to take a screen, and hold it rigid and parallel, good work can be done with it; but a little more care will be required, and very much

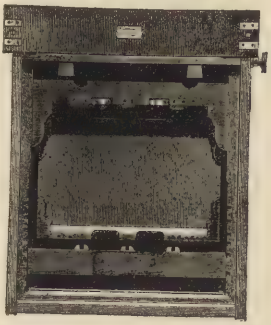


FIG. B.—SCREEN AND PLATE HOLDER.

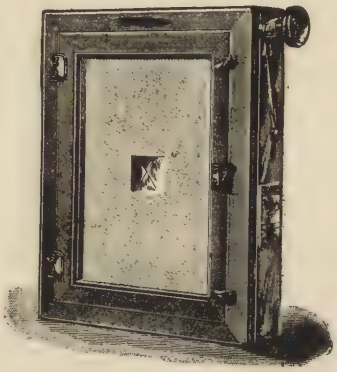


FIG. C.—SCREEN AND PLATE HOLDER FOR SMALL CAMERAS.

more exactitude will be necessary to choose the correct size of diaphragm.

Using the Screen.—The uninitiated operator might easily be excused for thinking that, given a screen, it only required putting in its place and making an exposure of the subjects through it; but such is far from being the case. In the first place, a knowledge as to the proper distance of screen from sensitive plate is requisite, and also the exact size of stop that will suit the particular subject in hand; and it is this last which takes the beginner the longest to quite understand. If the subject to be copied is of first-class quality, with true gradations from deep shadow to high light, a diaphragm, or stop, that bears the No. F. 16, will, with careful adjustment of the screen gear, give a perfect grained negative; but if the subject be either flat, or, on the other hand, a hard black and white one, then that stop will no longer be of service. In the

first case it will be too small; in the other too large. The above statement will suggest the question, What do we want? Well, here is the reply: From the subject to be copied we require to make a negative which, when held up to the light for examination by the naked eye, should give the impression of being a soft, delicate, and harmonious one; and, upon examining the whites with a strong magnifier, it is found that, instead of being of even density, they are broken up with a sort of chess-board pattern, with transparent holes at regular distances in between. In the half-tone the holes or dots are apart, and the shadows are peppered all over with opaque dots. Such a negative can only be obtained by the stop aperture, and screen distance being adjusted to exactly suit the subject being reproduced. Before going any further it will be necessary to say something concerning the shape of the diaphragm, and as this is a practical treatise and does not profess to go into ultra-theoretical matters, it will be sufficient to state that whilst the square shape, with and without cut-out corners, or with convex sides, are those most often advocated, the English firm (the oldest of the Bushey colony) who do the finest and best work in Europe, use round stops; this being so, it will be seen that the shape of the stop is not everything, skill and experience being the chief factors, and no matter which stop the student may decide upon (*i.e.*, of the four mentioned above), the directions to be given will apply to all equally.

Messrs. Penrose & Co. have introduced a patented set of diaphragms, with which is issued a small book giving directions for use. This system has been well tried, and is commended and used by many experienced operators, who have not been able to find any fault with it. With a set of these diaphragms, cut to fit the lens, it is only necessary to use the Tables of Screen Distances, in book of instructions, for the purpose of determining correct size of stop. The best method of working is to measure the extension of camera from the diaphragm to plate, look for the largest size stop permissible for this extension in the screen tables, insert the square stop of this size in the lens, and examine image on screen with the microscope over the transparent aperture in focussing screen, for the correct size of the dots, racking the screen to and fro till the dots appear as they ought to in the negative. The exposure

is made with this stop for the high lights, then insert a small stop, *e.g.*, F. 64, and with that in expose for the shadow dots.

Some operators get shadow dots in their negatives by using a very small stop as above, and moving a sheet of white cardboard in front of the print which is being copied. This is sometimes very useful when copying hard black and white subjects, but is not recommended for general work, as it is apt to give flat results, that require too much fine etching.

Lighting the Studio.—This ought to be done by electrical arc lamps, daylight being too uncertain a quantity.

Nowadays, when the installation of an electric light plant, suitable for a photo-process establishment, has been brought to a high state of perfection, instead of wasting space describing such installations, the reader is referred to a dealer's catalogue, where not only the plant all through will be described but also the prices and improvements up to date.

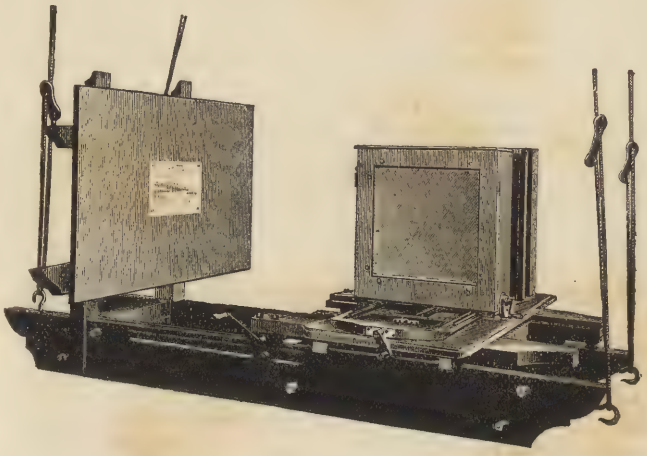


FIG. D.—SWING BASE AND COPY BOARD.

For shaky studios the newest appliance is here illustrated, and is one of the most compact and useful pieces of apparatus that can be imagined.

The Lens.—For the production of grained negatives it is necessary that the lens should be capable of giving a sharp image of the original, with a moderately large stop, because if the lens does not define properly without a smaller stop than that necessary for obtaining the requisite dot, then it will be impossible to get good results. The lenses most suitable are the new Cooke process lenses; after them any of the rectilinear or symmetrical type of lenses will do so long as they are not wide angle lenses.

Negative Process.—The question as to which process is best for the production of grained negatives, resolves itself into this—if you are an expert wet collodion man, and have suitable facilities for its practice, then by all means use it, as under those conditions it is undoubtedly the best and cheapest; if you are not up in wet collodion, but are intimate with the Collodio-Bromide process, then use that; but if you are a gelatine worker, pure and simple, then stick to gelatine dry plates. And here a word on the quiet. For grained negatives do not use the ordinary photo-mechanical or process plate, but use either the new half-tone process plate, or else a good ordinary gelatine dry plate, but the greatest care must be taken to have the window or developing lantern perfectly safe, this being the only thing likely to cause failure unless carefully attended to.

Prism v. Mirror.—On the score of economy and convenience a prism is better than a mirror. So long as the mirror is in good condition, then one is as good as the other, but a mirror requires constant attention, and in time will cost more than a prism, hence it is an economy to purchase the last-named at first. Both prisms and mirrors require careful adjustment to fit the lenses intended to be used with them, and this adjustment must be done by someone who understands thoroughly what he is about—more especially when a screen is used—as the slightest variation will give the impression that the lens is bad, and entirely prevent good work being done.

CHAPTER II.

MAKING A GRAINED NEGATIVE.

Preliminary.—We will suppose that an original is focussed, the distance between diaphragm slot and sensitive plate being 24 inches. Insert a diaphragm in lens, the square aperture of which measures 5/8 of an inch on each side, the sides of diaphragm opening being parallel with sides of camera. Now, by the aid of a focussing glass, examine the image of screen, and by means of the knob or lever, move the screen closer to or further away from the focussing screen, until the screen image is quite sharp; then move the screen just a little away, which will throw it the very slightest out of focus. Now, if a negative be made with full exposure, the result ought to be right—*i.e.*, the opaque squares in the whites are touching at each corner, and the shadows have round opaque dots all over. But this result will only be right if the original that is copied is one in which all gradations are present, from deep shadow to high light. If the original is a harsh black and white picture, then one of two things will be the matter—*viz.*, if a full exposure has been given, and the dots are all right on the shadows, then the high lights will be choked up; if the dots are right in high lights, there will be none on the shadows. In this case, a smaller stop must be inserted, and the screen put a little further away. This alteration will effect a cure, and upon another trial, the result will be right. If the original be a flat subject, without either high light or deep shadow, then the dots on the shadows are correct, and in the lights will not be joined at the corners; or if the dots in lights are joined, those in the shadows will be pretty nearly so also. The remedy in this case will be to insert a larger stop, and place the screen a little closer to the plate.

Making the Grained Negative.—First of all, the wet collodion method will be described. The process itself is written in full in Chapters I. and II., Part I. of this book, and to those chapters nothing further need be said than this:—Patent plate glass should be used for these negatives, and the plates should be very carefully albumenised, in order to guard against dirty glass and other troubles, such as the film slipping or blistering, etc.

We will now suppose that a negative is ready for development, as it is here that the real making of the negative commences. Flood the plate with developer in the usual way, and allow it to act until the shadows seem to fog slightly. At this stage, an expert will examine the negative with his magnifier, and judge at once whether the dots on the shadows are sufficiently developed, and also if any access of density is required by them. But for a beginner to attempt this would result in having the negative stained; therefore, at first the novice must content himself with developing as long as is safe without clogging the shadows. Now wash under tap, then fix in cyanide, and again wash. Then comes the examination. First of all see that the negative is clean and free from spots or stains, &c.; if not, put into a dish of water and try again. If it is quite clean, get the magnifier and examine the dots on shadows, and if these are strong and of equal density all through, try the lights. Here we must have square opaque dots, the corners touching distinctly—if they overlap, so much the better—and the space between the square opaque dots should be nearly transparent. All these points being correct, the next operation will be to clear the negative; this being done as follows:

Iodide of potassium	1 ounce.
Iodine	¼ ,,
Water	20 ounces.

Of this take 1 ounce, to it add sufficient of a strong solution of cyanide of potassium to discharge the red colour, leaving the mixture quite clear, and dilute to 10 ounces. Give the negative a rinse under the tap; drain slightly, and flood with the clearing solution. Allow this to act (carefully watching the negative) until the shadows just begin to brighten, then at once wash off the clearing solution. Now examine the dots in the

shadows, and if they are reduced in size to a fine pin-point, growing larger and larger until the half-tones are reached, the action of the clearing solution has been good. Now look at the lights. Here the transparent dots should be clear and bright, whilst the opaque ones should just touch each other at the corners. If the above results are not obtained, a second application of the clearing solution will be necessary; but great care must be exercised, or the whole image will be affected and spoilt. Never examine a negative without a previous wash, and do not be in a hurry, but apply the clearing solution again and again (washing between each) until the desired result is attained. The negative at this stage will be too thin for use, therefore it must be intensified. This can be done either by the lead method (page 16), or the copper bromide (page 46). In using the former, bleach the negative thoroughly, wash under the tap until the yellow film is removed, then flood with the acid solution; again wash and flood with the sulphide, wash, and clear with the acid solution. Again wash, and the negative is finished. Next examine the dots: those in the extreme shadows must be merely pin-points, firm and shapely, and quite opaque, getting larger until the half-tones are reached, but still far apart and opaque. In the lights the opaque dots must be in perfect touch at the corners, and the transparent ones between quite clear. Large dots in the deep shadows will cause flat results, and if too small or not opaque, they will cause sooty blacks.

If the copper bromide method of intensifying be adopted, bleach in the mixture of A and B. Wash, and then flood with the nitrate of silver solution. Again wash, flood with nitric acid mixture as used for lead intensifier; wash, flood with sulphide; wash, flood with acid mixture; wash, and the negative is finished. Great density can be got by repeating the operations, taking care not to omit the acid wash between each operation.

To obtain successful results care must be taken, first, in stopping the action of the clearing solution directly it has cleared the shadows on the transparent dots; second, that the acid wash is used between all the stages of intensifying, with, of course, copious washing in between. A good negative has a nice silky look with it, but an indifferent one looks harsh.

The negative being finished, it must be drained, then flooded with a strong solution of gum arabic, carefully filtered; and again drained and dried. Careful operators can omit the gum varnish, but it is just as well to use it, as it renders the dangers of scratching the film less during the printing.

Before the negative is ready for printing, a great deal of after trouble is avoided if lines are cut through the film, leaving the required size of block inside the lines.

Any spots, &c., in negative, may be touched up now, or left to the etcher.

In certain periods of the year, when using the wet collodion process, there is often a very distressing phenomenon—viz., screen-sweating. Sometimes this can only be got rid of by warming the screen before each exposure, but a very good remedy is to rub it over with glycerine or vaseline, and polishing off again. White wax dissolved in benzole can also be used, great care being taken to avoid leaving polishing marks behind, but the real remedy for this phenomenon is to keep the temperature of the studio perfectly even, then all the apparatus will be of one temperature, and sweating will be avoided.

CHAPTER III.

GRAINED NEGATIVES ON DRY PLATES.

For this purpose the specially prepated gelatine dry plates, labelled "photo-mechanical," or "process" plates, are not the best; those that are called "half-tone process," will be found better. Failing these, any good ordinary plate may be used, (in fact some operators prefer them). The secret of success is simply this: be sure and have the light in dark room perfectly safe, then there will be no trouble.
The best developer for use is this:

DEVELOPER FOR DRY PLATE.

No. 1.—Water		9½ ounces.
	Potassium bromide	90 grains.
	Nitric acid	10 minims.

Mix and pour into a one-ounce bottle of pyrogallic acid.

No. 2.—Sulphite of soda, pure and free from carbonate		1 pound.
	Water (cold) up to	80 ounces.
No. 3.—Carbonate of soda (washing soda)		12 ounces.
	Water up to	80 ounces.

If there be any efflorescence on the washing soda, wash it off before dissolving in the quantity of water given above.

For use for a half-plate negative take No. 1, 2 drms., No. 2, 6 drms., No. 3, 8 drms., and mix.

As a rule, it will be found necessary to use a diaphragm a trifle smaller with gelatine plates than with wet collodion ones. A full exposure must be given, and at the same time care must be taken that the dots in shadows are not made too large.

Development.—It will be found very advantageous in development to adopt Mr. A. Watkins' method of timing the operation, using his little instrument, the eikronometer, for the purpose. The method is as follows:—Have the developer

mixed, put the exposed plate into the dish (carefully shielded from any direct light), then turn the travelling pointer of the eikronometer close to zero, and when it touches zero, pour the developer over the plate (beware of air bells), rocking gently, until there is the faintest appearance of an image. Then look at the eikronometer, note the time that has elapsed since the developer was poured over the plate, and multiply that time by six. Put the dummy pointer to the product, and when the moving pointer is opposite the dummy the negative is fully developed. Remove, and at once immerse in the hypo fixing bath. When all visible, unaltered bromide of silver has been dissolved, wash the plate for half-a-minute, then immerse in a second bath of hypo of usual strength, and let it remain for at least five minutes, then wash and examine.

As an example of using this method of development, suppose that the action of light shows itself forty-five seconds after the developer is poured on the plate, in that case, at the expiration of 4½ minutes from the time the developer was poured on, the negative will be fully developed. Of course, a watch can be used for the timing, but the eikronometer will be found a great convenience. The negative being fixed and washed, it must be examined with the aid of the magnifier, and the general appearance of the image should be about the same, as in a wet plate negative, except that the opaque squares in lights should only just touch; if over joined, there may be a difficulty in clearing the transparent dot. In the shadows the dots must be small, but opaque and quite free from raggedness.

Clearing the Negative.—This can be done either with the same solution as is used for wet collodion plates (used in a dish), or the ordinary reducer of Farmers—viz., a mixture of hypo, 2 ounces, water, 1 pint, and as much of a saturated solution of ferricyanide of potassium as will suffice to make the hypo a yellow colour—or another clearing solution made by adding 1 ounce of hydrochloric acid to a pint of the ordinary iron developer used for wet collodion can be used. Whichever of these clearing solutions are adopted, it will not be necessary to give any prolonged washing to the negative after leaving the hypo fixing bath. In fact, for neither of the two last named is washing required, especially if the second fixing bath is clean, as it should be, and will be if the negative is properly washed

after being taken from the first hypo fixing bath. Whichever of the three clearing baths are used, the procedure is the same as for a wet collodion negative—viz., to clear away fog or veil from the shadows. When the operation of clearing is finished, a thorough washing must be given, and the negative then intensified.

To do this, it is first bleached until white in

Bichloride of mercury	1 ounce.
Chloride ammonium	1 ounce.
Water	20 ounces.

When dissolved, add ½ dram hydrochloric acid.

When the negative is white, wash thoroughly, and then immerse in a saturated solution of sulphite of soda until the image is quite black through to the glass, again wash and allow to dry. The blackening of the washed, bleached image can be done with a strong solution of carbonate of soda, or by immersion in a mixture of water 10 parts, ammonia 1 part.

Gelatine dry-plate negatives sometimes stain when intensified, that is because they have not been properly fixed, hence the necessity for using the two hypo fixing baths.

Plenty of washing is necessary between each operation, but unless the negative is properly fixed all the washing in the world will not prevent stains.

Before putting a gelatine negative to dry, always go over it with a pad of wet wool, to remove any scum that may be adhering to the film ; and, if the negative be wanted in a hurry, soak for three or four minutes in clean methylated spirit, wipe over with the wool dipped in clean spirits, and the film will dry clean.

Dry-plate negatives are prepared for printing in the same way as wet collodion negatives.

CHAPTER IV.

PRINTING ON THE METAL.

The Enamel Process on Zinc.—What is called the enamel process is the one now almost universally used, and it will receive the most attention. In this process the principal substance used is a glue that is soluble in cold water; and this implies a glue of a low quality, which, as a matter of course, is impure to such an extent as to prevent anything like a clean film being obtained. Therefore, to make such glue fit for use, it must be clarified, to get rid of the dirt and grease. A method of doing this will be given in the Appendix. There is on the market a clarified glue (Le Page's fish glue), which gives excellent results; at times, however, this glue does not work quite satisfactorily, unless mixed with some proportion of home-clarified glue. Many formulæ have been published for the glue mixture, but this one has the merit of being well tried:

Le Page's fish glue	3 ounces.
Ammonium bichromate	120 grains.
Chromic acid (sat. sol.)	5 drops.
Whites of fresh eggs	3 ounces.
Water	10 ounces.

This solution is carefully mixed, then filtered through flannel or felt.

The zinc plates must be round polished. They are cleaned first with a mixture of washed whiting and ammonia, this being rubbed on and off with a soft cloth, the plate is then grained as described on page 58. After this, wash and rub with a plug of lint or cotton wool; then put on whirler; whirl to get rid of water; examine to see that no dust or dirt is on the surface of the plate, and if there is any, wash off. The plate being quite clean, flood with the glue mixture; whirl; again coat and whirl (this time gently), and hold over a good atmospheric gas-stove until the film is quite dry. Care must be taken not to dry too rapidly, or the film will scorch and be useless. The gas-stove must be a good one, burning with a clear blue flame, and the plate must not be approached too close. A good plan

is to have either a gauze cover over the gas-stove, or to have an iron plate over it, then the heat will be more even and under control. The film being dry and even, with a nice enamel gloss, it is ready for the printing frame. Take the negative from which the print is to be made, warm it over the gas-stove, place the sensitive film in contact with the negative, put into printing frame, screw up, and expose to light. The exposure to light is not a very long one, from one to five minutes in good weather being an average. An actinometer may be used in dull weather, but in a fine bright light timing will be found best.

Developing the Print.—If the print be put direct into water there will be a difficulty in judging whether the image is all there; therefore, a solution of a red or blue aniline dye should be used, in which the image is stained; then upon washing away the film that has not been acted upon by the light, the image can easily be seen. After washing, if the colour has not had time to stain the image thoroughly, immerse again for a minute or two, then remove and wash. Now take the magnifier and carefully examine the print, beginning with the high lights; here we must have a perfect succession of dots, each quite apart from its fellows; there must be no break in the continuity of these dots; and they must be perfectly sharp and firm. In the shadows there must be a continuity of white dots in the film—very fine in the deepest shadows, and gradually growing larger to the darker half-tones; and unless the print answers these requirements, it must be at once washed off and another try made, because, if the dots in lights are not clear, firm, and continuous—or the dots in shadows open—no amount of after work can produce a satisfactory block.

Burning in the Image.—The print being all right, it is well washed and dried, either spontaneously or by the aid of gentle heat; then it is ready for burning in, an operation necessary to enable the image to withstand the action of the etching acid. This burning in or carbonising ought to be done on a hot-plate, but it can be done over an ordinary gas-stove, the plate being held in a small hand-vice. With zinc plates the greatest care and judgment are required not to carry the carbonising too far, or else the metal perishes and melts. At first the action of the heat destroys the aniline colour, but directly afterwards, the image assumes a light brown, which speedily gets

darker, and if the plate be not now withdrawn, the image will be quite black, and simultaneously the metal will go, and the image turn to a grey. Therefore, be content with a dark brown image; it will give as good a resistance as is wanted, and be perfectly safe. Allow the plate to cool gradually, then it is ready for the etcher.

Printing on Copper.—Copper plates should also be round polished for half-tone blocks; they are cleaned with washed whiting and ammonia, then dropped into a weak mixture of water 1 pint, perchloride of iron solution (40° B) 1 drachm. Rock the dish for a moment, then remove plate and wash, and then immerse in mixture of chromic acid 1 drachm, sulphuric acid 1 drachm, water 40 ounces. Here they will clear, thoroughly wash, put on whirler, and treat exactly as for zinc. All that has been written above for zinc applies now for copper, so there is no need to repeat the process—the only alteration necessary being this:—copper being capable of withstanding a greater heat, the carbonising can be carried further without any fear, the result being that a finer printing surface is obtained. Brass plates are manipulated exactly in the same way as copper right away through.

Failures and their Remedies.—A formula has been given for the fish glue mixture, but it is not possible to give one that will always work properly, for the simple reason that all samples of fish glue are not alike; hence it will often be necessary to modify the above formula, either by adding a little more glue, or a little more or less water.

If, when the print is placed in the dye, on lifting it out, the image looks all right, but on washing the print the image comes away from the metal, then the film is too thick, and the glue mixture must be diluted. Under-exposure is shown in a nearly similar manner, except that the shadows do not come away so readily; but the latter will, of course, occur, in gross under-exposure. If the glue mixture is too thin, the image will not take up sufficient dye to give a good image, and if burnt in, will either split up, or directly the heat has discharged the dye the image turns a dirty grey, and will not alter. If the glue in use is brittle, the addition of a little sugar to the mixture will counteract that defect; and if the image looks spongy when dry, add a little gum arabic.

CHAPTER V.

ETCHING HALF-TONE BLOCKS.

Zinc Plates.—Before etching it will be necessary to see that the border lines are on the plate. If these are scratched through the film of negative, all that need be done will be to draw a fine line inside the black ones, so as to give a white line inside; but if the border lines have not been cut on the negative they must be drawn on the metal with varnish. Also any touching up that is required should now be done, and the back and margins coated with varnish.

The etching bath must not be too strong. Commence with a mixture of water 80 ounces, nitric acid 2 ounces, and either rock the dish, or brush over the plate with an etching brush. In the margin should be scratched a fine line or two as a guide during etching, but care must be taken not to scratch into the metal. As soon as these guide marks give a good grip to the finger nail, remove the plate from the etching bath and wash and dry. Now paint over with resist, or stopping out varnish, all those parts which must print a rich black; and when the varnish is dry, cut other guide marks in the margin and etch again. As soon as the new marks show a grip for the finger nails, remove and examine the dots on high lights—they should still be firm and fairly *fat*; if so, continue etching for a little time longer, and then remove and wash. Now paint out everything but the high lights, and again etch until the dots are reduced somewhat in size. Another plan is to apply the etching fluid with a brush on those parts it is desired to make print lighter. Both methods are good, and depend entirely on skill. In fact, after the first two etches, each plate will require to be treated in its own way.

The one cause of failure in etching—*i.e.*, when the image is all right—is hurry. Take plenty of time and examine the progress frequently with the aid of the magnifier.

After the first etch, it is often necessary to roll up the image in order to keep the dots from being etched whilst a little extra depth is obtained. To do this it is necessary to provide a good glazed roller, charged with fine etching ink; the plate is warmed and the roller passed over it, when the ink is deposited on the image, and, if the glazed roller is charged with an excess of ink (the plate being hot), the ink will run over the edges a little and protect them, and afterwards the fine etcher can take advantage of these edges being a little under-cut to get brilliancy.

Copper or Brass.—For etching on copper or brass, perchloride of iron, at 40° Beaume is best, and as this mordant fills up the etched space, it should be followed by immersion in a solution of

Chromic acid	1 dram.
Sulphuric acid	1 dram.
Water	20 ounces.

This clears away the deposit and shows exactly what action has taken place.

The perchloride solution acts very slowly, but it gives a nice straight etch. Allow it to act for 10 minutes, then remove the plate, wash and immerse in the chromic acid for five minutes. This will clear away the dirty deposit, and will enable the action to be seen at once. Repeat the operations alternately until sufficient depth has been attained.

Part IV.

PHOTO-LITHOGRAPHY IN LINE.

CHAPTER I.

PHOTO-LITHOGRAPHY IN LINE.

THE process of photo-lithography is a means whereby a copy of a drawing or engraving, in line, dot, or stipple, can, by photographic aid be put upon stone, such drawing, &c., being photographed the same size, enlarged or reduced. A photo-transfer properly made can be transferred to stone with as little trouble as an ordinary transfer written, drawn, or pulled from plate, or stone, and will give as good results. These transfers can also be made from an original (*e.g.* a lace curtain) and in that case not only will the lithograph print be truer, and better than a drawing but the cost will be greatly reduced. Photo lithography is a great saving in many branches, for instance labels, where with one subject many sizes are required, this, whether done by hand, or by mechanical means, is costly and tedious, but if black impressions are taken from each stone of the original, and these photographed to the various sizes wanted, the result is good in every way. Again with paper bags, when one picture, &c., has to do duty on many sizes, one drawing only is requisite, the other sizes being furnished by photo-transfer. In these cases better work can be put into the original, and this better work will show itself all through the series.

The most important stage in the production of a photo-litho transfer is a good negative, in which the image is perfectly sharp from corner to corner, the lines being represented by clear glass, and the whites of original by as near opacity as possible. (N.B. a photographic negative is the reverse of a positive, and is always judged by being looked through). A tolerable idea of a photo-litho negative is seen in a reverse lithographic print in which the reading matter is represented by white letters on a black ground, except that when the film side of the negative is held next the face such reading matter will be

reversed as regards right and left. These negatives can best be obtained by the wet collodion process treated of in Part I. of this book, the other photographic methods wherein dry gelatine plates are used not giving the results wanted. A specially prepared dry gelatine plate, called the photo-mechanical or lantern plate, can be used, but the results are rarely so good as can be obtained on a wet collodion plate, whilst those plates in ordinary use for portraits, views, &c., are entirely useless for this purpose.

The camera and lens are also very important factors in the production of a good photo-litho negative, the camera must be built for strength, not lightness, it must be of sufficient length to enable a copy to be made of the same size. Thus for plates 15 × 12 inches, a lens having a focal length of twenty inches is requisite, therefore the camera must open out to at least forty two inches. Cameras made for out-door work with all the latest improvements are not at all suitable for copying, even if they do draw out a sufficient length, they being far too light to resist the slightest vibration. Cameras for photo-litho are best without any of these improvements, as they are a nuisance rather than a help.

The lens must be of the rapid rectilinear or symmetrical type, no other being of any use. Portrait lenses (Petzval type), single view, and wide angled lenses, single or double, must be especially avoided, as none of them will give the definition required, except the wide angle rectilinears: these, however, are objectionable on account of their short focus, which brings the camera so close to the original that the light is cut off, and consequently the exposure is prolonged.

The room, or studio, in which the camera is worked must be well lighted, and the floor solid, else the camera will vibrate during exposure, and the image in consequence be blurred. Where it is not possible to get a firm floor, a long board, to which the easel is attached, may be suspended from the roof or ceiling; the camera put upon this board will then give negatives free from blur, because the apparatus will vibrate, as a whole, and the blur be neutralised. The easel, or board, upon which the original to be photographed is fixed, must be perfectly parallel with the front of camera, both horizontally and vertically, else the picture will be distorted.

The camera stand must be a solid box moving on wheels, which run in grooves or upon rails. In fact, everything must be solid and substantial, nothing at all flimsy being of any use. A focussing eye-piece is requisite to enable the highest degree of sharpness to be obtained on the ground glass. A good opaque cloth is also required to cover the head and ground glass of camera during this operation.

Whether negatives are made regularly or only occasionally, good apparatus will be best, as then all the faculties can be concentrated upon the production of good work; whereas, if the apparatus is ricketty, and presents difficulties in working, it is almost impossible to turn out anything at all passable. The photographic manipulations require quite sufficient attention without having to fight with bad tools, as well as with a photographic process. Many firms who have tried photo-lithography, and given it up, have failed solely for this reason; get good apparatus, and the process of photo-lithography will be quite easy to work, and will be a source of profit.

In Part I. a full description is given with working details of the wet collodion process, and if details are carefully followed, and in an intelligent manner, little difficulty will be experienced in turning out good negatives; but the tyro must not expect to get good negatives straight away, practice and experience being as necessary in photography as in any other science.

Keep every bottle duly labelled; never mix any of the chemical solutions. Keep all dishes for their particular solution, and, above all, keep everything clean. Keep the dark room for its special work and do not make it a lumber room. Dust is a great enemy to good photography, and rubbish harbours dust, so keep dust out of the dark room. Let the only operations done in the dark room be collodionising, sensitising, development, fixing, washing, and bleaching. Clean the plates (except albumenising, which may be done in the dark room), and use the sulphide of ammonium outside. In fact two dark rooms are wanted, one for the negative, the other for the other operations, including the making the transfer. The negative dark room window will require an orange light, but the other dark room window can be covered with one thickness of yellow paper.

The Transfer is made by exposing to light in a suitable

frame, under the negative, a sheet of paper coated with gelatine, and made sensitive to light by floating upon a solution of bichromate of potash. The light shines through the clear portion of the negative, such clear portions being the lines, dot and stipple representing the image. The gelatine beneath these is made insoluble, and incapable of absorbing water, but the gelatine under the opaque portions of negative representing the whites of original is not impressed by light, therefore it still retains its power of absorbing water. After this exposure to light under the negative the picture can be seen in brown lines on a yellow ground. The print is now covered with a thin film of transfer ink, and immersed in clean cold water, when the gelatine not impressed by the light absorbs water, and in a short time the ink on these portions can be wiped off; but, on the lines where the light has altered the gelatine, water is not absorbed, so the ink remains thereon, yielding a replica of the original, the picture being formed of transfer ink. Such in brief is the rationale of producing a photo-litho transfer; the description is simple, and so is the process, that is, if the proper tools are used.

The Transfer Paper.—This can be purchased ready for sensitising in two forms—viz., Husniks, which merely requires soaking in a solution of bichromate of potash, and drying in the dark; or the Autotype single transfer paper, which may be used after floating upon a mixture of albumen and bichromate, and drying in the dark. The paper may be prepared at home, but unless done in large quantities at a time, scarcely pays for the trouble. For those who would like to try the home preparation, formula will be given, which, if followed, will be satisfactory.

The Drying Box.—The most important piece of apparatus in connection with photo-litho transfers is the box in which the paper is dried after soaking in or floating upon the bichromate solution or mixture. It is imperative that the paper at this stage be dried in a heated current of air, quite free from deleterious fumes, or the gelatine will be rendered non-absorbent of water all over instead of merely on the lines forming the image. This drying must be done in a closed box, hanging in a warm room not being so good because there are times when the air is more impure than at others, and vexatious

uncertainty is the result. With a closed box a uniformly good result can be obtained. The drying box may be described as follows:—an upright box 30 inches high, 24 inches wide, and 15 inches deep, standing upon stout legs about 12 inches high, with a full-sized door in front; the bottom of the box is of thin sheet-iron flanged downward all the way round with a flange 6 inches deep. This bottom is fixed to the box with screws or nails; at the back of the box a small aperture, say 3 inches in diameter, is pierced in the sheet-iron flange, and this is connected with a pipe, the said pipe being conducted into a convenient flue or chimney, so as to convey away the products of combustion from the source of heat. About one inch from the bottom of the box a series of holes, half an inch in diameter, are bored through the wood at close intervals all round the box. These are for the ingress of air, and at the top of the centre is a hole about 6 inches in diameter, which is covered either with a tube to form a chimney or with a flat cap 12 inches in diameter, and raised about two inches from the top of the box. This is for the egress of the warm air, the temperature of the air inside being ascertained by means of a thermometer suspended in a small recess cut in the side of the box and glazed with a piece of glass. The box is heated by a small atmospheric gas stove under the sheet-iron bottom. A paraffin stove may be used instead, but is not recommended, as it is so difficult to keep this class of stove from an occasional smoke. About 4 inches from the top inside the box are fixed cleats, one on each side, say about 1½ × 1. These cleats go the whole depth of the box, and are exactly opposite each other, upon these cleats will rest six or eight wooden rods, about one inch square, to which there is to be pinned the sensitised paper when hung up to dry. The temperature at which the paper is dried is only about 80° F.; a higher temperature will make the paper brittle, and difficult to manipulate. A box of the size given will suffice to dry six or eight full-sized sheets in about an hour, at the temperature named. This box should be stood in a quiet corner of the room where it would be free from sudden draughts, and the bottom should be covered with a layer of clean white sand about half an inch deep. This will be a good precaution against sudden draughts outside the box.

The Printing Frame.—This must be of the box pattern,

with plate glass front, the pressure being obtained by means of screws ; a good thick pad of clean smooth felt should be provided for each frame, so as to get the paper well into contact with the negative, the plate glass front should be at least half an inch thick, and great care be taken in screwing up so as to get the pressure even. In cold weather, after exposure outside, the pressure should be taken off slightly before taking the frame inside, or the sudden transference to a warm room will cause a smash.

The Inking Board.—This is formed of two boards hinged together, of the following dimensions :—For full sheets of paper, a small board 20 inches long, 3 inches wide, one side to be rebated ; the other board 20 inches long, by 24 inches wide, also rebated at one end. This rebate to go over the rebate on the small board, these two boards being hinged together at the rebated ends, with the hinges underneath, and sunk so that when the double board is laid on the bench it will lie flat.

When the board is made it must have three or four coats of good shellac varnish, so that when it is used for a small print the ink can be removed with a little turpentine and a rag. The size of board given can be easily modified for smaller transfers, one in which the smaller board is 12 × 3 inches, and the larger one 12 × 17½ inches, being a convenient size for half sheets of paper.

The Roller.—To ink up the print after exposure to light a roller of gelatine, &c., as used by typographic printers, is the best ; the methods of using an inked stone in a litho press, and of rubbing on the ink with a rag or sponge being obsolete. This roller should be in a light frame, and the composition should be hard and with very little tack. Winstone's supply a very good one for the purpose, being made specially.

The Transfer Ink.—Any good re-transfer ink (stone to stone) may be used, either home-made or purchased. This is very important, and can be bought ready-made, or can be made. Winstone's Photo-Litho Transfer Ink is the best to buy, though sometimes the ink used by lithographic transferers will answer quite well, the requirements being a short fatty ink that will hold where it gets encouragement, but not where it is not wanted.

The following formula gives a first-rate ink for zinc printing, and also for photo-litho transfers :

Mutton fat	1 ounce
Beeswax, pure, not white	1 ounce
Soap	1 ounce
Shellac	1 ounce

The mutton fat is got by rendering in a clean earthenware vessel the best kidney suet, placing the vessel in the oven, and when properly rendered, straining through muslin into another vessel to cool.

To make the ink, an iron saucepan fitted with a lid is required, and it should be made on a fire with an open chimney, to allow of firing the mixture during making. First put the mutton fat in the saucepan and put on the fire. As the fat melts it will give out a crackling sound, and must be boiled until this sound ceases, and the liquid boils without noise; now add the beeswax, a little at a time, and when this is all added, boil until quiet again, then add the soap (any good pure soap will answer), a little at a time; and when the crackling again ceases, add the shellac; by the time the shellac is dissolved, the mixture will be ready to fire; apply a light and let it burn until the whole is reduced in bulk to about half, then put on the lid of saucepan, which will extinguish the flame, withdraw from the fire, and when somewhat cooler add four ounces of the best chalk litho ink, stirring it well until it is thoroughly mixed and melted, then pour into a jar and allow to cool, and the ink is ready.

For thinning this ink a good sample of turpentine should be used, which should be perfectly free from paraffin oil, such an admixture resulting in dirty whites. Turpentine for this purpose is best, purchased at a chemist's who does not deal in paraffin oil. Those who do sell both, are sometimes difficult to convince that merely using a funnel that has previously been used for the oil, will spoil turpentine for our purpose. The writer has met with this difficulty, and as the result was a lot of wasted time deems it of sufficient importance to give a word of warning to others.

Dishes.—These are required for sensitising the paper, and for soaking the exposed and inked-up prints; they may be of tin or of zinc, and should be of sufficient size to take the full size

of print well. For whole sheets 26 × 20 × 4 inches deep, for half sheets 20 × 15 × 4 are good dimensions. Keep them for this purpose only, and keep them clean.

For wiping off superfluous ink, good surgical lint, or fine swansdown is recommended. Always have a good supply, and change it frequently so as to avoid dirty or scratched transfers. Clean blotting paper is required to free the transfers from surplus moisture before pinning up to dry, in order that they may dry flat instead of curly, as they are apt to do if pinned up without blotting off. When the transfers are flat, they are easily manipulated, if curly there is always a risk of smearing.

The Sensitising Solution.—For photo-litho transfer paper the best all round salt is the bichromate of potassium. The bichromate of ammonia *may* be used with advantage in very dark weather, or in hot muggy weather, but it is rather expensive, and the advantage gained is not of such a nature as to justify its employment always, a solution of bichromate of potash to which has been added a little liquor ammoniæ being capable of giving quite as good results. The bichromate of soda cannot be recommended, it being an amorphous salt, and deliquescent. Paper prepared with it must be kept so carefully as to be well nigh useless, the only advantage that is really claimed for it, viz., its increased sensitiveness is not of sufficient importance to compensate for its drawbacks.

CHAPTER II.

PHOTO-LITHO TRANSFERS ON HUSNIK'S PAPER.

THIS paper as purchased will keep for any length of time, so long as it is stored in a dry place, but will soon be spoilt by damp. To make it sensitive it is immersed in a solution of

Bichromate of Potash	1½ ounces.
Water	16 ,,

Powder the bichromate before adding to the water, then dissolve by shaking the bottle, add half a dram of liquor ammonia ·880, shake up, and after adding 5 ounces of methylated alcohol, filter into a clean dish. Immerse the paper in this and allow it to remain for three minutes, then raise one end and pin to a rod from the drying box. For a full sheet use five or six pins, raise the sheet gently from the solution, and let it drain until the liquid ceases to drip, then place the sheet in the box, which has already been heated to about 60° Fah. Sensitise as many sheets as are required for the day's work, but no more, as the sensitive paper does not keep in good condition more than a day.

When the paper is sensitised, return the bichromate solution to the bottle, wash out the dish, and then carefully wash the hands, as a solution of bichromate of potash is poisonous, and with some constitutions it causes troublesome ulcers. These however may be avoided by at once washing the hands after using it, and not allowing the bichromate to dry on the skin.

When the paper is dry, the gas should be turned off under the drying box and allowed to cool. When quite cold the paper is cut up to the sizes required and the printing frames filled in, but previous to this the negatives must be looked over, and any defects removed. Pins used to keep the drawing flat must be covered with a wash of india ink laid on with a sable brush, the holes in the film being also covered with ink. No particular

care is requisite in doing this except that the lines must not be touched. In cases where the picture approaches the extreme edge of paper, a wash of india ink will give a broader margin to the transfer. If a correction has been made on the original, and such correction is a strip of paper stuck on the face, the joint will show in the negative, and this must be covered up with the india ink. In extreme cases where the original has been upon a yellow paper, or the picture was in pale or blue ink, a deal more painting out is sometimes necessary, and it is far better to do it on the negative, than to do it on the stone. When this is all done, clean the back of the negative carefully.

In putting the sensitive paper upon the negative, care must be taken not to scratch the film, which is very tender and won't stand much hard usage. Cut the paper about an inch longer than the transfer is required, and having put the negative into the frame, film upward, place the paper, glazed side down in contact with the film, put the felt pad upon the paper, then put in the back, and screw up, getting the pressure even all over. The frame is now put outside for exposure, to direct sunlight if possible. In a good light this exposure is not very long; for direct sunlight, from five to ten minutes being ample, if the negative is good. If this is at all weak a shorter time will be necessary, or the whites will be dirty, but with a perfect negative the time is not much consequence; in dull weather the exposure will vary from half an hour to two or three hours. The progress of the action of light can be seen by opening one end of the frame, but this course should not be adopted until it is judged that the exposure has been sufficient, because relaxing the pressure, and exposing the print to the influence of the atmosphere is apt to cause it to either expand or contract, and the exposure not being sufficient, the frame is closed and re-exposed, a blurred image will result, so that great care must be taken in making an examination of progress.

Directly the paper is dry after sensitising in the bichromate of potash solution, great care is needed to shield it from white light, so the printing frame must be brought into the dark room for examination of the print. The print may be said to be sufficiently exposed when the whites are *just* beginning to show that the light has penetrated the opaque portions of negative.

When the print is sufficiently exposed it is removed from

the frame, and is ready for inking up. To ink up the print, a little transfer ink is put on the inking slab, sprinkle over this a little turpentine, mix the two together until thoroughly incorporated, the mixture being quite thin, take the roller and roll in the ink, now lift the inking board at the hinges, insert about half an inch of the plate in the slit, let the board go flat down, and the print will be held tight during the operation of inking, now run the roller over the print from the top, lifting it each time as it gets to the bottom, until the ink is dry.

This is a very important stage, the film of ink put on must be thin and even; if at all thick the lines will squash in transferring, the film of ink put on must not be thick enough to obliterate the image, which should be seen through the ink. Beginners are apt to put on too much ink at this stage, and it is only after a little experience that the intelligent operator gets to understand the importance of a thin film of ink. More photo transfers are condemned because of over inking than from any other cause, in fact it is a very common reason why these transfers are not liked, they don't give sharp transfers, the reason being too much ink has been put on.

The print being inked is allowed to rest a few minutes in order that the turpentine may evaporate, then it is immersed in clean cold water, here it remains for about twenty minutes, when it is laid upon a sheet of glass or zinc, and the face gently rubbed over with a wet pad of lint, this will loosen the ink from the broad whites, and partially so from the other whites. After a little further soaking, all the ink on the whites can be removed, and if the yellow bichromate is also soaked out, the transfer is ready for blotting off, but if not, a longer soaking is necessary, as all the bichromate must be removed before the transfer is dried; the ink on the lines adheres with some tenacity, so that the rubbing with the lint to get all the whites clean can be done without fear of breaking or clearing the lines, so long as the transfer and pad are kept wet. In cold weather, or with old paper (*i.e.*, long sensitised) the water in which the print is soaked, may be used warm, say 70° F. but the transfer will require more careful handling as the ink is easily smeared.

After blotting off the transfer, pin it upon a clean board with a pin at each corner, leaving a little play so that in drying the pins do not stop the contraction of the paper.

CHAPER III.

PHOTO-LITHO TRANSFERS.—VARIOUS METHODS.

To use the autotype transfer paper make a solution of

Albumen (white of egg)	10 ounces
Water	20 ounces
Bichromate of potash	1½ ounces
Liquor ammoniæ	½ dram

Dissolve the bichromate in the water, add the white of egg well beaten up, then the ammonia, filter through four thicknesses of muslin into a clean dish, and float the paper upon this for three minutes, then pin on a rod and put into the drying box. If the paper has been rolled it will be difficult to get it to float evenly on the bath, in that case, cut it into convenient sized sheets, and with a sponge slightly damp the back of each sheet, then lay them in a heap under a sheet of glass for an hour or so. After this they may be floated upon the bichromated albumen solution.

Another method of sensitising is as follows. Make a stock-solution of gum tragacanth composed of

Gum tragacanth (in powder)	1 dram
Alcohol	1 dram

shake up well, then add

Water	20 ounces

this will at once result in a thick mucilage.

Of the above solution take	10 ounces
Water	20 ounces
Bichromate of potash	1½ ounces

filter this through muslin into a clean tin dish, and float the autotype single transfer paper upon it for three minutes, then pin to the rod and transfer to the drying-box.

The after operations with either of these papers are the same as with Husnik's paper as described in the previous chapter.

CHAPTER IV.

DIRECT PHOTO-LITHOGRAPHY IN LINE.

THE previous chapters treat upon photo-lithographic transfers upon gelatinised paper, which, whilst easy to work, presents certain difficulties, chief of which is the almost impossibility of getting the exact scale, this being caused by the well-known fact that paper is always very erratic in its stretch after soaking in water. This stretch can be allowed for up to a certain point, but no absolute reliance can be placed upon this allowance, therefore a process whereby the transfer can be placed direct upon the printing surface must go far to emphasise the utility of photo-lithography.

To utilise a stone for this purpose is quite out of the question, for two reasons: first, on account of its cumbrous nature, and secondly, because of the porosity which effectually prevents any photographic method being of practical utility; hence for a direct method we must utilise the more modern and convenient zinc printing surface. Zinc can be used *au naturel* or with a prepared surface, the last being the best, as the preparation of the plate, without in the slightest interfering with the sharpness of the image put upon it, helps the process of printing, by giving a hold to the moisture so necessary in lithographic printing to keep the whites clean.

When plain zinc is used it requires to be well polished, then grained by immersion in a mixture of

Nitric acid	1 ounce
Water	1 gallon
Alum	1 dram

This mixture is used in a large wooden tray lined with pitch, the plate being immersed until the polished surface is quite

destroyed by the acid leaving a dull matt-surface in its place All the time the plate is immersed in this solution the tray must be kept rocking, in order to disperse the gas bubbles that otherwise must form upon the surface. After sufficient immersion in this acid mixture the plate is removed, well washed under the tap, and the scum or oxide removed by gently rubbing with a very soft sponge or a pad of wet lint or cotton wool, after this the plate is placed in a whirler (see Part II., Chapter II.,) and is coated with a mixture of

White of egg	1 ounce
Water	10 ounces
Bichromate of potash	1 dram
Liquor ammoniæ	½ dram

the ammonia being added after the other ingredients have been well mixed together. Sufficient of this mixture is poured over the plate to well cover it; the plate is then well whirled, in order to properly equalise the film. The plate is then removed from the whirler and the film dried over a spirit flame, or over a gas stove, the plate being kept moving, so that the film dries evenly; after this the plate is exposed in the printing-frame under a line negative; this negative being a reversed one, that is, the image is in its correct position as regards right and left when the film is held next the face. The exposure to light, inking-up, &c., are the same as for paper transfers, and the subsequent working, either for transfers or for working on machine, will be just as usual for ordinary zinc plates.

The prepared zinc plates now in the market, and used for originals, and also for substitutes for stones, are admirable for direct photographic printing, and require no preparation of any kind previous to coating with the sensitive mixture. This mixture—bichromated albumen as given above or bichromated tragacanth as given in Chapter III.—flowed over the plate and whirled, then dried over a spirit flame or a gas-stove, when it is ready for exposure under the negative. The inking-up is done with a glue-roller and transfer-ink thinned with turpentine, the rolling being continued until the turpentine has evaporated, leaving a thin even film of ink upon the surface; this film of ink must be thin, or the image will be thick. This is a crucial stage, and one that is very difficult to describe, so the learner must be prepared for a few experimental trials at

first ; it is, however, far easier to put too much ink on than too little ; in fact, it is almost impossible to put on too little.

There is one drawback to the use of these prepared plates, viz. :—once used, if the print is from any cause a failure, the plate will have to be used as a piece of plain zinc (after cleaning off the image and preparation with a rag dipped in pumice powder), or be returned and be re-coated ; but if the negative used is a good one—*i.e.*, has *perfectly clear lines*, with opaque whites—and sufficient exposure is given in the printing-frame, there is very little reason for failure. The plates being flexible, can be examined when in the printing-frame, and that without any risk of contraction or of expansion, as is the case when paper is printed upon ; absolute scale and size can be relied upon when these plates are used, as they can be used either as originals from which to pull transfers, or can be printed from on machine or press. Direct photo-lithography must command a position of usefulness.

CHAPTER V.

PHOTO-LITHOGRAPHY IN HALF-TONE.

In photo-lithography in line the transfer is made from a subject with the half-tones translated in line, or stipple, by hand; in photo-lithography in half-tone, the translation has to be effected either by mechanical or chemical means.

Nearly all the mechanical methods yield results that are either unsatisfactory, or which require an inordinate amount of hand work upon them that in a certain way detracts from their utility, but are easy to work, and do not call for a very great amount of skill in working; by the chemical methods transfers can be obtained, that with intelligent printing will yield results closely competing with collotype.

Many methods have been published from time to time for printing the image direct upon stone, but this is not at all likely to be in even the slightest degree, either commercially, or practically, successful, first on account of the bulky nature of the stone; secondly, because of its capacity for absorption of any fluid; thirdly, a stone used for the purpose is spoilt, and cannot be of much service again.

The new patent lithographic zinc plates offer a very good substitute, and the coarser surfaces are capable of yielding a transfer that in clever hands will give very good impressions.

Perhaps the best method of using a mechanical grain is to grain a litho stone, or a zinc plate, with coarse sharp emery. Work this over with a chalk crayon, etch and roll up with a good hard printing ink; a sheet of prepared photo-litho transfer paper is impressed by being pulled through the press in contact with the inked up and grained stone. This paper is then sensitised by immersion in a solution of bichromate of potash (the paper may be sensitised before impressing with the

grain, providing the litho press is in a yellow lighted room, or lit by artificial light). When dry, this paper is exposed to light under an ordinary half-tone photographic negative, after exposure is damped by immersion for a few minutes in cold water, put on the inking board, and rolled up with a glue roller charged with litho transfer ink thinned with turpentine, this rolling being continued until the image is fully developed. The grain impressed from the stone having prevented the light from acting upon the sensitive paper comes away, and so breaks up the image in a manner sufficient to print on stone; such an image is coarse, and without most part of the delicate gradation of the photograph, therefore this method has never been so much practised as its simple nature would warrant.

Half-tone transfers are also made from negatives, in which the half-tones have been broken up with a screen placed in front of the sensitive plate; from this grained negative an ordinary transfer is made upon photo-litho paper, the image being developed by rolling up with a roller charged with transfer ink thinned with turpentine. Rubbing off the ink with cotton wool cannot be managed in this process, the lights being so small it is difficult to prevent the image from being scratched. Various methods have been proposed of breaking up the half-tones—*e.g.*, using wire gauge between the negative and sensitive paper, or using a negative made from the wire gauge; but as none of them are of any practical use they will not be discussed any further.

The chemical means of breaking up the half-tones depends upon very simple facts, the chief of which is "that a film of bichromated gelatine dried by heat will reticulate, and that reticulation will be finer, or coarser, according to the degree of heat at which the drying is conducted." The mere drying of a film of bichromated gelatine is not sufficient to cause a reticulation of such coarseness as to work from stone, but if various substances are mixed with the gelatine, then the reticulation can be made to assume very large proportions. Calcium chloride, ferricyanide of potassium, silver nitrate, &c., are examples of such substances, and by their aid, separately or mixed, a successful half-tone photo-lithograph is possible.

Photo-lithographic transfers can be made direct, or from a collographic plate, and, here again, little choice is possible,

the direct methods—*i.e.*, using paper as the support for the bichromated gelatine—are not sufficiently certain to enable them to be used on a commercial scale, the difficulty in working being caused by the thick coat of gelatine necessary to get a workable grain becoming unmanageable during the manipulations. The best method is the collographic, in which the gelatine is spread upon a glass plate, and from this the transfer is pulled in ordinary transfer ink upon Scotch or India transfer paper, and as each plate will yield at least twenty-five transfers, the process is far more certain than when a transfer paper is used, and which in case of accident will have to be done over again, entailing a delay of at least a day; and an accident can easily happen, a little too much ink on the print, or a slur in transferring, all will crop up occasionally.

The mechanical methods being quite obsolete, no further particulars will be given, but both the paper and the collographic methods will be fully described.

CHAPTER VI.

HALF-TONE TRANSFERS ON PAPER.

THE paper used should be a heavy writing paper, wove, *not laid*, the heaviest procurable is the best, as then, the tendency to curl will not be so great, or so troublesome as with a thin paper, in fact, a thin paper will not be workable at all; the paper selected requires to be tough, as it has to withstand repeated soakings in water, and if at all rotten will fail.

The Paper.—The paper being procured, the next operation will be to give it a preliminary coat of gelatine, in order to close the pores of the paper, and so prevent the sensitive coating from soaking into the paper. This is done by floating upon a solution of

Gelatine	5 ounces.
Water	40 ounces.

Soak the gelatine until it is quite soft, then put the jar containing this gelatine and water, into a pan of cold water, put this pan upon a gas stove, and gradually raise the temperature until the gelatine is all dissolved, add half a grain of a saturated solution of chrome alum, stir this well in, then add 2 ounces of acetic acid, stir well, filter through muslin into a warm tin dish, and upon this float the paper for three minutes, putting each sheet down carefully to avoid air bubbles, hanging up to dry after floating in a warm room. Paper so prepared will keep any length of time if kept dry.

Suitable paper can also be purchased ready coated; it is sold for the carbon process, and is called double transfer paper. It is sold in rolls 12 feet long, 30 inches wide, the rolls being called "bands."

The Second Gelatine Solution.—This is made as follows. Place in a clean jar

Gelatine (soft)	10 ounces.
Water	20 ounces.

Soak the gelatine till it is quite soft, place the jar in a pan of cold water, put this pan upon a gas stove, and gradually raise temperature of water until the gelatine is dissolved; add 2 ounces of sodium chloride, and 2 ounces of sugar. When these are dissolved, add half a dram of boracic acid, filter through muslin into a warm jar, and it is ready for coating the paper.

Coating the Paper.—Provide three or four sheets of glass, or of zinc of any suitable size, for coating full demy sheets the glass (or zinc), plate would require to be 23½ × 18½; for sheets about 11 × 9, the glass (or zinc), plate should be 12 × 10, this being ruled by the largest transfer to be made. Soak the gelatinised paper in lukewarm water until perfectly limp, then place it upon the glass (or zinc), plate, with the gelatinised side up, use a roller squeegee, so as to get the paper in contact with the surface of plate, remove surplus water with a piece of linen rag, then carefully level the plate; when level, pour upon the paper sufficient of the gelatine mixture to cover to a depth of one-eighth of an inch. For a piece of paper, 11 × 9, this will require three ounces of gelatine solution; for a demy sheet, ten or twelve ounces. The operation of coating must be done in a warm room, so that the gelatine cannot set before the plate is properly coated. The gelatine solution must be coaxed with the fingers to the edges of glass plate, and must not be allowed to run off. When coated, allow to set; then stand up to dry in a warm current of air. When the gelatine film is dry, it can be stored away for future use, as if kept dry, will keep in good condition any length of time.

Sensitising the Gelatinised Paper.—A drying box is now wanted, as to get the effect required, the next drying operation must be effected at a temperature of at least 90° Fah. This drying box must be properly ventilated, as the drying must be effected by a current of hot air, not by baking in a heated atmosphere.

A collotype oven (of which a description will be given when describing that process), is the best type of drying-box, the

plates to which the gelatinised paper is attached being stood up round the sides.

The sensitising solution is composed of

Bichromate of potash	1 ounce.
Bichromate of soda	½ ounce.
Calcium chloride	1 ounce.
Ferricyanide of potassium	1 ounce.
Water	30 ounces.

Filter this solution into a clean dish (of tin, or porcelain), and immerse the dried gelatinised plate; allow to remain for five minutes, then remove and stand on edge till it is drained surface dry; then put into the drying-box; when all the plates are in the box, light the gas underneath, and raise the temperature gradually to 90° Fah., and do not exceed 100° Fah. The drying will be complete in about 2 hours, and the plates are ready for exposure under the negative.

Exposure to Light.—The negative must be of good quality, full of detail, and rather inclined to flatness, a bold vigorous negative being somewhat unsuitable, the negative can be made by any process; the exposure must be sufficiently long for all detail in lights to be well printed, and, by preference should be conducted in diffused light, sunlight being apt to give an objectionable relief to the print. The exact time of exposure can only be determined by practice; it can be judged by putting out—at the same time, and in the same light—another negative of greater, with a piece of ordinary silver paper in contact, and withdrawing both when the silver paper is a little over-printed.

Development.—When the exposure to light is complete, the plate is immersed in a dish containing

Borax	4 ounces
Water	20 ounces

And allowed to soak for twenty minutes, then remove, wash under the tap, lay it on the bench, and with a soft cloth dab its surface dry; now the nature of the grain can be judged, the whole of the image being reticulated or wrinkled; if the reticulation is sufficiently coarse the plate is ready for inking up, but if too fine the plate must be immersed in lukewarm water, and here the grain will speedily get larger, and it can be controlled by using the water hotter or cooler; here is where judgment is

required and must be exercised. When the grain is satisfactory, and the surface free from moisture, take a glue roller charged with transfer ink thinned with turpentine, and roll up until the image is developed, bright and clean. When first the roller is passed over, the surface will be black all over, but in a few minutes the image will gradually take a definite shape, and, in a short time, will be fully developed. The next operation will be to soak for five minutes in a solution of

Sulphate of iron	1 ounce.
Water	80 ounces

This is to harden the gelatine; wash under the tap for a minute, then immerse in a solution of

Bichromate of potash	1 ounce.
Water	80 ounces.

Drain and stand up to dry. When dry expose to light for five minutes; this is to deprive the gelatine of its absorbent properties, and prevent swelling when put into the damping book.

To Transfer to Stone.—Cut the paper just inside the edges, and strip off the glass plate, then put the transfer into the damping book until limp. Put a warm and polished stone in a litho press, trim the transfer as required, put it carefully face down upon the stone, put on the backing sheets, lower the tympan, and pull through five or six times without raising the tympan; then after pulling through with heavy pressure raise the tympan and lift off the paper, and the image should be transferred to the stone; if without slur, gum in, and put on one side for twelve hours before attempting to roll up.

CHAPTER VII.

PHOTO-LITHO IN HALF-TONE FROM COLLOGRAPHIC PLATE.

For this process a collotype oven will be required capable of being heated up to 180° Fah. A full description of this oven will be given in Part V. dealing with the collotype process. The plates must be dried in such an oven, as the success of the process demands that to obtain the necessary grain, the gelatine must be dried at a high temperature.

The Plate.—British plate glass is used to put the sensitive film upon, as that alone can be used economically. Plates of brass or copper may be used, but they are so easily bent that they are not recommended. The plate glass used should be at least three-eighths of an inch thick, but it will be far the best to have it half an inch thick; this thickness is more expensive at first, but it pays best in the long run, as it withstands the pressure in press better.

The plate is ground on one side with fine emery, then well cleansed and scrubbed in order to get rid of all traces of the emery; a final cleanse with soap powder and a thorough wash will render the plate ready for the substratum.

The Substratum.—If the film of gelatine be dried upon the glass without any substratum it will not hold on sufficiently to enable a print being pulled, but with a good substratum the film will hold as long as required. The plate is dried, then covered with a little of the following mixture:

Beer	10 ounces
Porter or stout	10 ounces
Silicate of soda	2 ounces

This mixture must be well filtered before use, and will keep mixed for weeks. When the plate is coated it is stood on a

rack to dry in a warm room, and when quite dry is rinsed under the tap to wash away any free silicate there may be; after rinsing the plate must be again dried, then it is ready for the sensitive coating. Plates that have been coated with the silicate and beer must be rinsed—*i.e.*, slightly washed—at once, or else the silicate will rot the gummy deposit from the beer and in that case will be useless for the purpose intended, but when dried after rinsing will keep good any length of time.

The Sensitive Coating.—When dried after rinsing, the plates are placed in the oven and carefully levelled, then warmed to about 130° Fah. Whilst the oven and plates are being warmed the sensitive mixture is made up as follows:

Soft gelatine	1 ounce
Water	3 ounces

Soak gelatine in the water, in a clean jar, till quite soft, put the jar in a pan of cold water, place this pan on a gas stove, and gradually raise the temperature until the gelatine is melted, stir with a glass rod to facilitate the mixture; when the gelatine is dissolved add

Bichromate of potash	75 grains

in a fine powder, adding a little at a time, and stirring well until dissolved. Next add 10 grains of calcium chloride, when dissolved and mixed add 30 grains of ferricyanide of potassium, previously dissolved in one ounce of hot water; finally, add 10 drops of acetic acid, strain through muslin, and coat the warm plates, allowing two ounces of the solution for a plate 15 × 12. As the plates are coated return to the oven, and when both plates have been coated close the oven, and dry at a temperature of 140° F. The drying will occupy about one and a half hours, and the temperature should be kept steady; when dry the plates are ready for exposure under the negative.

Exposing to Light. The negative must be reversed, and must be rather flat, with all detail present; it may be made by any process, wet or dry.

The time of exposure will vary, from three hours to all day, according to the strength of the light, and this can only be accurately determined by practice. It is far better to err on the side of too much than too little, because an over exposed plate will yield a good transfer, but one under exposed will not do so.

If the negative is smaller than the plate the edges of plate must be protected from light by a mask, else it will be difficult to get a clean transfer, on account of the ink coming off the margin. The printing frame is the same as used for collotype printing, pressure being obtained by means of wedges. When the exposure to light under the negative is completed the plate is washed in cold water for about half-an-hour, then the surface is carefully dabbed dry with a soft cloth, or with blotting paper, in order that the grain can be examined. If the grain is sufficiently coarse a further soaking of cold water is given until all the bichromate is washed out of the whites; but, if not, the plate is soaked in warm water (about 70° F.), which will develop the grain to the requisite degree, then wash in cold water and stand the plate on edge to dry.

Pulling the Transfer.—For this purpose a lithographic press is used, the glass plate being placed upon a lithographic stone, with a sheet of wet blotting paper underneath the glass plate. The back of glass plate must be carefully cleaned from gelatine that may have run over the edges. Grit, &c., must also be cleaned off; if these precautions are not observed the chances of a smash are many. Cover the surface of plate with water and let it stand in a pool all over whilst preparing the roller and transfer ink. The roller used is a good black lithographic roller, the ink a good re-transfer ink (stone to stone) used a little stiffer than for ordinary transfers. When it is judged that the plate is sufficiently wet ("etched" is the usual term), remove the water with a sponge, then dab with a soft rag, and proceed to roll up; the ink does not at first take very kindly to the image, but, with patience, it will soon ink up nicely. Do not try to get a vigorous image, as such a one will be troublesome in transferring. When the image has been rolled up, clear it with a good composition roller, such as are used for collotype, or with an indiarubber roller, then pull a proof. If the proof is satisfactory, damp over with a wet sponge, dab with soft cloth, roll up again, and pull a proof upon well rolled Scotch transfer paper, or upon India transfer paper, and repeat the operation until a sufficient number of transfers is obtained.

Should the plate roll up black, and refuse to clear with quick rolling, wash out with turpentine and water in the usual way, then etch for twenty minutes with:

Glycerine	1 ounce.
Water	5 ounces.
Liquor Ammoniæ	½ dram.

Cover the whole film with this, removing when time has expired with a sponge, returning to bottle for future use; roll up again and try proof. When glycerine is used to damp the plate, three or four transfers may be pulled without any damping between. Should the image refuse ink from the roller try a thinner ink on the roller, and if this is not efficacious, let the film dry a little.

The printing of these transfers is much the same as collotype printing, and the tyro will be repaid by reading the chapters upon Printing from the Collotype Plate in Part V.

Part V.

COLLOTYPE.

CHAPTER I.

THE NEGATIVE.

THE negative is the principal item in the production of a good collotype print; it can be made by any process, and upon any kind of dry plate, the requirements are, a soft delicate negative with a slight indication of over exposure, so as to keep the shadows from being filled up with ink. Negatives for collotype require to be reversed, and as it is always difficult to make negatives from nature exactly the size wanted, it is generally more convenient to reproduce, especially is this the case when two or more prints are to be made upon one sheet, as then the negatives must be flexible in order to get them all of equal thickness, in fact, unless patent plate glass be used to carry the negative films, flexible negatives are always desirable.

In the reproduction of negatives a transparency should be used, and this transparency is best when made by the Carbon process, there being no other method of making transparencies, either in cost, or in quality, that can compete with this process. When the very best results are necessary, the transparencies *must* be so made, as no matter how skilful an operator may be he cannot produce transparencies in any other way that can for a moment compare with those made by the Carbon process. In addition to other advantages which the process of reproducing the negative has, there is the scope given for improvement upon the original; from a weak original a bold vigorous negative can be made, and from a harsh negative, a soft one. Carbon transparencies are easily intensified by flooding with a strong solution of permanganate of potash, and when the original negative is dense and harsh, the transparency is made upon ordinary carbon tissue, instead of upon transparency tissue. When an original negative is used, should any accident

befall it, loss and inconvenience will be caused; but when a reproduced negative is broken, or scratched, another can be made at once.

Flexible Negatives on Wet Collodion.—In using the wet collodion process—and it cannot be beaten in economy or quality—the negatives are made upon polished plates, and after development (and washing) are intensified with

No. 1.—Pyrogallic acid	60 grains
Citric acid	30 grains
Water	1 ounce
No. 2.—Nitrate of silver	30 grains
Water	1 ounce

After the developer is thoroughly washed away, sufficient of No. 1 to well cover the plate is put into a small cup. To this 10 or 20 drops of No. 2 are added, the mixture is then poured on and off the plate until the requisite density is attained. If any portions require a little extra density, this can be accomplished by repeatedly pouring the solution on those portions, which are thus built up in density. If this is done carefully, no trace of such local intensification will be apparent.

All reproductions from indifferent originals should be done by the wet process, because this process lends itself so readily to the skill of the operator who can easily produce an improved result. When the negative is intensified it is washed, then fixed, again washed and dried. Now it can be stripped in two ways; first, it is carefully levelled, then covered with

Gelatine	5 ounces
Water	20 ounces
Sugar	1½ ounces

For a plate $8\frac{1}{2} \times 6\frac{1}{2}$, three ounces of the above will be required, the gelatine should be carefully strained through muslin, and should not be hotter than 110° F. when poured upon the negative. When the negative is coated the gelatine is allowed to set, then the negative can be put on a rack and allowed to dry in a warm current of air, and when dry the film is stripped off. In coating a batch of negatives that are intended to be printed all together, care must be taken that each negative is level, and also that each has exactly the same quantity of gelatine upon it.

Another way, and in many respects a more satisfactory one, is as follows :—Procure a large sheet of plate-glass, quite free from scratches, clean this with a little spirits of wine, then level carefully, and coat with

Gelatine	7 ounces
Water	20 ounces
Sugar	2 ounces
Sulphuric acid	1 dram

Add the sulphuric acid when the gelatine is melted, then strain through muslin, and pour upon the plate (24 × 20). Commence pouring at the edges, and gradually work into the centre, touching any air bells that form with a piece of sharp wood or a quill tooth-pick. When the gelatine has set, the plate can be stood on one side until the film is quite dry, which will be, on an average, in three days. When dry, run a knife blade between the glass plate and the gelatine film all round the edges, and the film can be lifted off. In this condition it is kept and cut up into sizes as required. The surface of the glass plate can be ground before coating with the gelatine, and the film when taken off will be matt on one side.

To use these films, or skins, cut to the size of the negative to be stript from the glass plate, soak it in cold water for three minutes, wet the film of the negative under tap, then slide into water under the skin, adjust the skin in its position over the negative, then remove the negative with skin adhering to film, put on a bench, cover with a sheet of indiarubber cloth, and squeegee vigorously, using a scraper squeegee (not a roller). The plate is then put away to dry. When the skin is quite dry it can be stript away from the glass carrying the collodion film with it.

If the negative be required in a hurry, directly the skin has been squeegeed down, it can be lifted with the collodion film adhering to it, turned round, and replaced on the glass, the collodion film on top. Soak it in methylated spirits for a few minutes, and it may then be dried at the fire.

For negatives suitable for collotype the chemicals must be in first-class order, the collodion ripe, the silver bath in good condition and of full strength, the developer old and clean, the plates well polished and of good glass (old dry-plate glass must not be used); in fact, everything must be working in

complete harmony. Then the negatives will be very satisfactory, the collotype plates from them will work well in press or machine, and the prints run the best silver, or platinum, prints marvellously close.

On Dry Plates or Films.—When dry plates are used it is necessary to strip the films—an operation simple enough, but one which has too much risk for commercial purposes. To strip an ordinary gelatine negative it should be well alumed, washed and dried, then the operations are :

1. Clean the back and edges carefully, as if pieces of the gelatine film are left on the back, or the edges, they become detached, and are apt to lodge on an important part of the negative during the operation.

2. Level carefully ; for this purpose place the negative on a levelling stand, or upon three wedges, and use a good, long spirit level.

3. Cover with plain collodion, pouring on nearly as much as the plate will hold without running off, make the collodion flow right up to the edges and corners. The collodion is to prevent the film from frilling, or stretching, and if not sufficiently thick the gelatine film will curl, and be difficult to handle when detached from the glass plate. The film of collodion must be allowed to set thoroughly before the plate is disturbed.

4. When the collodion film is firm to the touch, the plate is immersed in a dish of clean cold water, until the ether and alcohol is washed away, the water flowing over the film smoothly when they are removed, instead of being repelled as it was when first immersed.

5. The plate is immersed in an ebonite dish containing :

Water	80 ounces
Fluoric acid	2 to 4 ounces

Rock the dish gently until the film commences to lift at the edges, then remove, and wash under the tap. Commercial fluoric acid varies greatly in strength, hence the uncertainty as to the quantity required ; it is purchased in gutta-percha bottles, and should be kept well corked ; mix only sufficient for the negatives in hand, as the mixture can only be kept in gutta-percha bottles.

6. Place a plate which has been coated with gelatine (and

dried), in a dish of water, coated side up, take the plate (5) still carrying the film and put it (film side down) upon the surface of the water; the film will leave the glass and float upon the water; put the glass plate away, lift up the glass plate in the dish, gently adjust the film upon it, remove plate and film from the dish, squeegee the film down, soak in spirits of wine and put on a rack to dry.

This is for a single negative; if a number of negatives are to be put upon one plate, mark out the positions of each upon a sheet of paper, lay the glass plate coated with gelatine upon this paper, and having floated the films (one at a time) off the original glass plate, lay each in position as required, cover the whole with a smooth sheet of india rubber cloth, and squeegee them into contact with the gelatine; soak in spirit and allow to dry.

The plates to which these films are finally attached are coated with:

Gelatine	2 ounces
Water	20 ounces
Chrome alum	20 grains

Dissolving the chrome alum in the water before soaking the gelatine therein. When the gelatine is dissolved add 2 drams of acetic acid, stir well, filter through muslin, and flow over the clean glass plate, drying the film by placing the plate on a rack. These plates when coated may be stored till wanted, as the film keeps any length of time.

To make flexible negatives clean a glass plate, coat with a thin film of plain collodion (Mawson's Enamel Collodion answers well), and let this dry. The plate, when cleaned, is held on a pneumatic holder, the collodion poured on, the surplus being returned to the bottle.

When the film of collodion is dry the plate is levelled and coated with the gelatine solution given above for coating collodion negatives, allowing five ounces of solution for each plate 12 × 10, larger or smaller sizes in proportion. When the gelatine has set, the film may be allowed to get dry, or the stripped films may be mounted upon them at once and dried afterwards, but do not use spirits of wine to facilitate this drying. When this method is practised the compound film requires two or three days to dry, but if the

gelatine film is allowed to get dry before mounting the negative upon it, the compound film will dry in a few hours. When dry the compound film can be easily detached from the glass plate. Dry plates are now in the market specially prepared for stripping. They are manipulated exactly in the same way as are ordinary plates until dry, then they are either levelled and covered with gelatine, as above, or a gelatine skin after being soaked in cold water is squegeed in contact with it, and when dry the two films are stripped off the glass plate.

For developing gelatine negatives for collotype, pyrogallic acid and carbonate of soda should be used, pyro-ammonia or hydrokinone not being satisfactory, the following formula being the best yet published:

STOCK PYRO.

Water	8 ounces
Sulphite of soda	2 ounces

Dissolve in a jug and pour into an ounce bottle of pyrogallic acid, label stock pyro. This will keep good for three or four months.

DEVELOPER.

No. 1.—Stock pyro	2 ounces
Water	18 ounces
No. 2.—Carbonate soda (crystals)	3 ounces
Sulphite soda	1 ounce
Bromide potash	30 grains
Water	20 ounces

For normal development equal parts of Nos. 1 and 2 are used, but the conditions of normal development are seldom present, therefore judgment must be used, and the two constituents combined in such proportions as will yield the best results. If the negative is being made from a flat transparency, give a good exposure and develop with one part of No. 2, two parts No. 1. If the transparency has harsh contrasts, reverse these proportions. The addition of a drop or two of a solution of potassium bromide, 60 grains, one ounce water, will often be required to give brilliancy; in fact, the mere possession of a good formula is in itself of little account. There is an ingredient required that is seldom mentioned, and that is "judgment." Take the three solutions that go to make up a developer, and mix them in such proportions as will suit the particular negative in hand. Never use a mixed developer

a second time, but make a fresh mixture for each plate or film. When making reproductions from transparencies, or from prints, it is a good plan when two or more negatives have to be printed upon one plate to make all the exposures, and then to develop the lot in one dish. By so doing one is much more likely to obtain uniformity of density than when each plate is developed separately. After development wash the plate, and immerse in solution of alum for ten minutes (strength of alum not very important), again wash, and fix in strong hypo made slightly acid with sulphurous acid, or by the addition of one ounce of sulphite of soda to each pint of hypo solution. The washing between the alum bath and the fixing solution must be thorough, or a nasty stain is caused.

Celluloid films are strongly recommended for negatives for collotype, as then a flexible negative can be obtained without the expense and trouble of stripping. Celluloid negatives are manipulated exactly like those upon glass, and present many advantages which need not be further enlarged upon.

CHAPTER II.

APPARATUS, &c., FOR PREPARING THE COLLOTYPE PLATE.

For preparing a collotype plate we require an oven in which the film can be dried in a hot current of air, and in a horizontal position; glass plates at least three-eighths of an inch thick, if thicker still they will be economical; fine flour emery, gelatine, bichromate of potash, methylated spirits of wine, half-a-dozen test tubes each of two ounce capacity, two small beakers or two small jugs, a jam pot holding about ten ounces of water, a tin pan about six inches in diameter, four inches deep; a small gas stove (or a paraffin stove), a set of scales and weights, glass stirring rods, printing frames, tinfoil, thin opaque paper for marks, stale beer, silicate of soda, funnels for filtering, muslin or swansdown for filtering.

The Oven.—The oven is an oblong box of a suitable size for the particular plates dried in it, and as the actual cost of coating a plate is so small it pays best to have one, or at most two sizes of plates in use. This will be specially the case when a machine is used for printing. In building an oven the maximum size of plate should be ascertained, and the oven made to take either two, four, six, or eight of such plates, this particular number being determined by the size of the room in which the oven is to be placed. The dimensions of an oven to dry two plates, each 15 × 12 inches, will be 32 inches long, 20 wide, 24 deep, and, if more than two plates are to be dried at a time, the two first dimensions will be altered, but the depth will remain the same no matter how much larger or smaller the oven may be.

The body of the oven, as above, is of wood one inch thick, and stands upon four legs eighteen inches from the ground.

The bottom of the oven is an inverted tray made of thin sheet iron 52 inches long, 19 wide, 9 deep (or high). This is screwed to the bottom of the wooden body, the top of the sheet-iron tray forming the bottom of the oven. At each side of the tray will be a space between the wooden side and the side of the top of tray forming a ventilating space for the admission of cold air into the oven. The appliance for heating may be a long atmospheric burner supported upon bricks under the mouth of the sheet-iron tray; or if the tray is fitted with a ventilating pipe, a U-shaped burner fitted with four small burners upon each arm may be used. Paraffin stoves can also be used for warming the oven, but they require an inordinate amount of watching to prevent smoking. The lid of the oven is formed of two frames fixed at the corners, one above the other. The lower one is covered with common red flannel, the other with American cloth. The supports at the corners will leave a space of about half-an-inch, through which the heated air can escape. In the centre of the lid a long glass thermometer projects, the index being outside, but the bulb close to the plates when drying. The plates are supported upon bars, two bars for each plate. One bar has two long screws nine inches apart, the other bar one screw in the centre only. These screws are about six inches long, ¼-inch in diameter, and these bars are supported upon cleats screwed upon the sides of the oven about twelve inches from the bottom.

Glass Plates.—These should be of British plate glass, at least three-eighths of an inch thick; half an inch is better, as they will bear far more pressure, and are not so liable to break during printing. These plates are to be ground upon one side with fine flour emery, using a small piece of plate glass as a muller. Very fine flour emery must be used, as if the emery is at all coarse the result will not be good. The Wellington knife polish sold in tins is a good article for the purpose, and can be purchased in places where flour emery is not procurable. After grinding, the plates must be well washed and scrubbed with a brush, and this brush must be kept for the purpose, and free from contact with soap or grease. The above remark refers to new plates; plates that have been used will require to have the old film removed. This can be done by immersion in a strong solution of potash lye washing, grinding with

emery, re-washing and scrubbing. Or the old film can be removed by means of a mixture of 2 ounces of fluoric acid and 20 ounces of water. Sufficient of this mixture to cover the film is spread all over with a piece of rag (don't touch it with the fingers), and the film will frill and come away in a sheet. After this the plate only requires washing and scrubbing. A final rinse and a scrub with a dry soap powder, such as Hudson's, is a very good preventive of grease.

Gelatine.—This must be of the best quality, Kreutz's or Simeon's being the best in the market. In summer time hard gelatine is required, in winter a mixture of hard and soft is better; a good supply should be got at a time, because no two samples are ever alike. Each will accordingly require different treatment, only to be determined by experiment. Gelatine must be stored in a perfectly dry place, damp will soon spoil it.

Bichromate of Potash.—This must be pure and in fine powder; bichromates of ammonia or soda are not recommended, both being uncertain in their action.

Spirits of Wine.—Methylated spirits (the ordinary commercial) are used, and merely require the addition of a dram of *liquor ammoniæ* to neutralise the ingredients added by order of the Excise authorities. With this addition of *liquor ammoniæ* methylated finish can be used. If the pure spirit—to be obtained by permit—be used, the addition of one dram of the Balsam of Tolu to each pint of spirit must be made.

Printing Frames.—These are of the box pattern with plate glass fronts, the pressure behind being obtained by means of wedges. It is not usual to employ the usual back to these frames, but to have for each frame a shallow wooden box; this keeps out white light from the back of the sensitive plate, and allows the progress of exposure to be ascertained without the risk of moving, as is the case when a back has to be opened.

Tinfoil.—Very thin tinfoil is fixed on the face of the negatives on glass to mark out the exact portion of the image required, and to give the sharp line required for pictorial effect. This tinfoil is attached to the film by a thin india rubber solution. When flexible negatives are used masks are made by cutting out openings in thin opaque paper, the negatives being attached to this paper.

Miscellaneous.—Amongst the miscellaneous articles re-

quired will be found test tubes and beakers; these are for holding the gelatine solution when hot and ready for coating the plate. Measured quantities must be used for this purpose, and as glass measures are so easily broken by heat, it is recommended to use test tubes, or beakers, with the quantities required marked upon the sides by a file. Funnels for filtering are required, and may be of tin or glass; cotton wool, or fine swansdown, is used, the last being best, as it can be used over and over again if it is carefully cleansed after each time of using.

For dissolving gelatine a water bath is always employed; to attempt the direct application of heat to the vessel containing the gelatine is to quite spoil it. Gelatine should be thoroughly soaked in cold water before heat is applied for the purpose of dissolving. For this purpose small jam jars are useful, this jar being put into a tin pan when it is to be heated; the tin pan being in turn placed upon a gas stove, or, failing this, a paraffin stove. Either of these stoves would be preferable to an ordinary fire, being free from soot and smoke, which cannot be avoided in an open fire-place.

Beer is required for the substratum or preliminary coating. Any kind of beer may be used, but preference may be given to a mixture of equal parts of beer (ordinary ale) and stout or porter.

Silicate of soda or potash are met with in commerce in two forms, viz., in a broken cake and in the form of a thick viscid liquid. This latter form must be used, the solid silicate being practically useless.

CHAPTER III.

PREPARING THE COLLOTYPE PLATE.

To prepare a collotype plate the following operations are necessary :

1. Grinding the thick glass plate with fine flour emery, or after once being used, removing the old film either with potash or soda lye, washing, grinding and scrubbing, afterwards drying the surface.

2. Coating with a mixture of beer and silicate of soda, and drying this coating, usually called the substratum. When this substratum is dry the plate is rinsed under the tap to get rid of the free silicate.

3. The plate is placed in the oven, carefully levelled, and warmed to 120°F.

4. The warmed plate is coated with a measured quantity of bichromated gelatine, returned to the oven, and the film dried at a temperature of 125°F.

The Substratum (2).—The operation of grinding has already been described. The plate, when dry, is coated with a mixture of

Stale beer	5 ounces
Silicate of soda	½ ounce

The two are mixed and filtered through fine swan's down ; if the mixture, after standing a few hours, assumes a jelly form, the proportion of silicate is too great, and a fresh lot must be mixed with less silicate. The mixture will keep for days, but must always be filtered just before use, as no matter how often it has been passed through the filter it will, after standing an hour or two, again require filtering on account of its constantly throwing down a deposit.

When the plate is coated with the mixture of beer and

silicate it is stood on end to dry, or placed on a rack. The coating must be dried in a warm room, and if there is any difficulty in getting a good substratum, on account of the want of a dry place, the plates must be dried in the oven—not necessarily in a horizontal position—as the glutinous matter in the beer must be coagulated, and this can only be done when the mixture is thoroughly dry. The silicate being somewhat deliquescent, a certain amount of heat is requisite to obtain this coagulation.

When the coating is quite dry the plate is rinsed under the tap for about a minute, this rinsing being necessary to get rid of the free silicate. The plate is again dried, this time either by heat or spontaneously as may be most convenient.

A plate, after the coating of silicate and beer is dry, must be rinsed at once as the film, if left, will soon be rotted by the free silicate, but when dry, after rinsing off the free silicate, can be kept any length of time without special precautions being necessary for storage.

The silicate of soda of commerce is, as regards its consistency, very variable; sometimes it is supplied in quite a fluid state, like glycerine, at others it is so thick as to flow with very great difficulty. When it is thick it should be diluted with water until of the consistency of glycerine, and then used as per formula given above, or if not diluted it must be used in proportions to be ascertained by experiments. Here judgment is required, as an exact formula is almost impossible. That given above refers to a consistency of silicate about that of glycerine. Silicate of soda in a solid state is not usable.

Instead of using beer for the preliminary coating, or substratum, albumen can be substituted, the formula for this being:

Whites of	5 eggs
Water	10 ounces
Silicate of soda	1 ounce

Separate the whites from the yolks and beat, add the water, beat, add the silicate, and again beat up. This is used exactly as directed for the beer mixture. Dried albumen can be used instead of fresh, in the proportion of 100 grains for each egg. Gum arabic, gum tragacanth, separately or together, mixed with sugar, glucose, &c., mixed with silicate of soda or potash, will give a good substratum for collotype.

The Sensitive Mixture.—Weigh out four drams of Kreutz's hard gelatine, and four drams of soft, put into a clean jar, with six ounces of clear water, let the gelatine soak until it is quite soft, put the jar into a pan containing cold water, placing this pan on a gas stove; as the water in the pan warms the gelatine will be dissolved, and should be stirred occasionally so as to facilitate dissolution. When dissolved add two drams of bichromate of potash in very fine powder, adding a little at a time, stirring vigorously all the time; by this means the bichromate is gradually and evenly dissolved. Keep the water in the pan just short of boiling point. After the addition of the bichromate, and when it is all dissolved, add half a dram of *liquor ammoniæ*. Stir this well in, remove the jar from the water bath and let the gelatine mixture get cold.

For use with the above there will be required a mixture of

Methylated spirits of wine	40 ounces
Balsam of tolu	1 dram
Liquor ammoniæ	2 drams

The Sensitive Coating (3 and 4).—This is a mixture of bichromated gelatine and of the solution of tolu in methylated spirits of wine. It is important that the collotype film be of a certain thickness; if too thin the image will be useless, if too thick the film will dry mottled. Experience teaches that the proportion of one ounce of a suitable mixture is correct, the suitability being determined by its properly flowing over the plate. In order to render these instructions thoroughly intelligible it will be assumed that two plates, each 13 inches by 11 inches, are being coated, so from these sizes and the quantities given, larger sizes can easily be calculated for. The size here mentioned, 13 inches by 11 inches, should be the minimum size used, smaller plates being quite as difficult to manipulate. Smaller plates, in fact, should never be used, as the roller used for inking up will be liable to be damaged; in fact there is no economy in using smaller plates than 13 inches by 11 inches.

To prepare the sensitive mixture for coating two plates, each 13 inches by 11 inches, put the pan of water on the gas stove and bring the water to boiling point, then extinguish the gas and in a test tube, previously marked with a file to show when it contains one ounce of fluid, put sufficient of the jelly

to make one fluid ounce when dissolved. Immerse this test tube in the hot water until the jelly is dissolved (it is as well to have a little over the ounce of solution because there is a certain amount of waste unavoidable in pouring out, one ounce and a half will leave a safe margin); in another test tube put one and a half ounces of the methylated spirit mixture, immerse this in the hot water until warm, take a small clean jug or jar, dip this into the hot water to warm it, drain the inside free from water, pour into it the gelatine, take the tube containing the spirit and pour the contents slowly into the gelatine, stirring the gelatine vigorously with a glass rod until all the spirit has been added. If this stirring be not done vigorously the spirit will coagulate the gelatine, converting it into a solid sticky mass and spoiling it. The gelatine now should be quite limpid without any signs of coagulation. Strain the gelatine mixture through a piece of fine swansdown wetted in hot water and squeezed partially dry. Clean out the two test tubes and put into each one ounce of the mixture and proceed to coat the plates. The plates must have previously been put into the oven, carefully levelled and warmed up to about 120° F. Each plate when coated with its proportion of gelatine mixture is returned to the oven, and when both are coated, the oven is closed until the films are dry, the temperature, as shown by the thermometer, to be 120° F.; the time necessary for this being about forty-five minutes. When dry, the plates are allowed to cool, and are ready for exposure under the negative.

Another formula for the sensitive mixture is this:

Hard gelatine	100 grains
Soft gelatine	100 grains
Water	2½ ounces
Bichromate of potash (in powder)	50 grains

Soak the gelatine in the water until it is soft, dissolve the gelatine, add the bichromate—a little at a time—stirring until it is dissolved, strain through swansdown, put into two test-tubes (previously warmed); coat the warm plates, return to the oven, and dry at 120° F. These films will take about one and a half hour to dry.

The film on the collotype plate when dry is sensitive to light, and must, therefore, be handled in a room illuminated either by gas or daylight filtered through yellow paper. The

room in which the oven is situated must be warm and dry, and free from draughts; if not, the film will not dry evenly.

Exposure to Light.—When a printing frame without a back is used the progress of printing can be seen without any trouble—the whole of the detail should be seen through the back—as unless the image is well exposed a good printing block cannot be expected. An actinometer is very useful with which to time the exposure to light. Perhaps the best form is a quarter-plate negative with a piece of paper under it, floated upon the following mixture:

Gelatine	2 ounces
Water	20 ounces
Bichromate of potash	¼ ounce

With such an actinometer the progress of the plate can be very easily gauged. Always give a full exposure, as with an over-exposed film it is still possible to get prints, but with one under-exposed it is not.

Washing out the Bichromate.—When the exposure under the negative is complete, the plate is immersed in clean cold water until the whole (or nearly) of the yellow colour of the film is washed out; this can be done in a flat dish, changing the water occasionally. The best plan is to have an upright box with grooves, in which to slide the plates. Such a box should have a tap at the bottom, by which the water can be withdrawn to make room for the introduction of fresh. Washing in an upright box clears the film of bichromate with fewer changes of water and more rapidly than in a flat dish. When the plate is sufficiently washed it is put on edge to dry, and when the film is quite dry it is ready for the printer, but it cannot be printed from without being dried first, as so much water has been absorbed as to render the film soft, and also incapable of taking ink.

CHAPTER IV.

PRESSES, &c., FOR PRINTING FROM THE COLLOTYPE PLATE.

PRINTING from collotype plates is done by hand press or machine. For hand-printing there are specially made presses, or lithographic and typographic presses may be used. The specially made presses require no comment, as they are fitted for the work in a very complete manner.

Lithographic Presses.—These require a bed for the glass plate, in the shape of a double-faced stone a little larger than the collotype plate; under the tympan (of leather or brass) is fitted a thin smooth blanket. If the tympan is of leather the scraper will need no alteration, but with a brass tympan the scraper must be shod with leather, fixing it at the ends, not along the sides of the scraper. Good heavy strap leather is best for this purpose. Various sized scrapers should be provided, so that one can be used a little larger than the picture to be printed.

Typographic Presses.—These are prepared by bedding a thick sheet of plate glass, of the same size as the collotype plate, in the centre of the bed, with a little thin varnish. Upon this sheet of plate glass a sheet of wet blotting-paper serves as the bed of the collotype plate. If the plate glass bed be half an inch in thickness and the collotype plate the same, no alteration will be required in the platen, as a little loose backing will give the necessary pressure. For a typographic press a good plan is to cement a piece of blanket to a sheet of millboard, then the blanket can be much more easily handled than if loose, and extra backing sheets can be put on when required. The tympan must be smooth, not filled in behind with uneven backing, or the plate will break. Of the two types of typo-

graphic presses the Columbian is better than the Albion, being less liable to cause fracture. A large press will also work better than a small one.

The Rollers.—Two rollers are required, one of leather, the other of gelatine and glycerine. The leather roller may either be a nap, or black lithographic roller, or a colour roller (lithographic). The first has the grain of the leather inside, and flesh side out; the other the grain outside. The nap roller requires greater care and time in preparing it for work; but when once in good condition remains so longer, and is more easily kept in working order. The colour roller can be got ready for use in a day or two, but requires constant attention to keep it in good working condition. A new nap roller is marked on the handle in the direction towards which the nap sets. To prepare it for use, hold it in front of a fire, and rub lard into it, until the skin has soaked in as much as it can do. When the lard is cold, scrape off, and roll up in strong litho varnish. This will bring out the nap. Roll up in this varnish a couple of days, at intervals; scrape off the varnish, and roll up in middle varnish, and gradually thin this down for two days; scrape and roll up in thin ink, gradually increasing the consistency of the ink until the roller is ready for use. After this, if it is possible, the roller should have a fortnight's work by a lithographer, then it will be in prime condition.

A colour roller is soaked with lard, scraped, rolled up for an hour or two in middle varnish, scraped, rolled up in ink, and is ready for use in two days. The best French or German skins should be used for collotype printing, English skins being too rough. Leather rollers are cleared of old ink by scraping with a blunt knife, the scraping being done towards the body, and with the nap. A pair of leather handles to cover the wooden handles of roller whilst using must be provided.

The other roller is of the ordinary typographic pattern, the composition being specially hard. Only a few firms supply these rollers, so special enquiries must be made before purchase as to suitability for the purpose. A good composition roller for collotype should be soft yet firm, and not tacky.

Inks.—Inks for collotype must be of the best. There are plenty in the market of all colours and tints, and if the printer

has by him black, bronze blue, indigo, maroon, sepia, venetian red, and middle chrome, any taste or subject can be suited.

Litho Varnish.—All inks will require more or less thinning down to working consistency; this is done with lithographic varnish, which is oil boiled and burnt to get rid of the fat. Lithographic varnishes are of two kinds, viz:—ordinary and tint, the first being of a brownish colour, and the last much lighter. For collotype "thin tint" or "middle tint" varnish is required. In very cold weather, or when printing upon enamel paper that has not been coated very long, cocoanut oil or lard may be used instead of varnish. To mix the ink and varnish a strong knife is required, a butcher's sheath knife being very good for the purpose.

Paper.—Collotype prints can be made upon any kind of good woven paper. Very soft, or laid papers are not suitable. As in every other illustrative method the best results are obtained upon coated or enamelled papers, of which class there are many in the market, the coating in some being very thin, in others quite thick. The former are used extensively by letterpress printers, the latter being what has long been known as "dull enamel" or chromo paper. When the last is used a sample must be chosen with a smooth back, the rough backed paper not being easy to print upon. All coated papers require age to give stability to the enamel, and where possible should be bought in bulk and stored. Collotype prints upon good plate or other rough-surfaced paper, are always appreciated; in fact, all tastes can be suited in collotype printing in the matter of the paper upon which to make the print.

Masking the Margin.—In order to print with a clean margin it is necessary to use a mask, which is placed in position for each print. On the machine this is done automatically, a special piece of apparatus being provided for the purpose. For printing on the hand press a light frame of iron, a little larger than the plate, with a sheet of parchment paper stretched (á la drum-head) over it, and then coated with gold size, to prevent the paper from absorbing moisture from the plate and causing it to stretch. A mask frame for plates 15 × 12 should measure inside 15⅛ × 12⅛, and be made of ¼ inch rod iron, round or square. To this the parchment paper is cemented at

the edges all round, and when the edges are dry the paper should be tight and smooth, the inside is then coated with the gold size, thinning down with turpentine. When the gold size is dry the mask is ready for use.

CHAPTER V.

PRINTING FROM THE COLLOTYPE ON THE HAND PRESS.

First of all it is essential to get the picture upon the plate into condition for printing. As it now is, with the film dry, a roller charged with ink would blacken it all over without showing the slightest sign of an image, but if the film be moistened with water, the gelatine will absorb water in inverse proportion to the action of light—*i.e.*, where the light has acted most upon the film when under the negative, no water can be absorbed because the light has hardened the gelatine to such an extent as to render the gelatine incapable of absorption, and where the gelatine film has been quite protected from the light the gelatine will absorb its full quantum of moisture. The result is, that in the first case the gelatine will take ink, in the latter it cannot. Thus we get, respectively, the blacks and whites of the picture, the half tones being rendered by the gelatine having being acted upon by light in due gradation from light to dark. From this it will be seen that before prints can be made from the plate it will be necessary to moisten the film so that when an ink-charged roller is passed over, the ink will take in those proportions necessary to form a picture, this moistening is called "etching"—a misnomer, but one that has so universal an acceptance that it is quite impossible to change it. Merely soaking in water is sufficient to enable printing to go on, but when water alone is used it is necessary to damp the film after each print, which entails a lot of useless labour, does not at all improve the resulting picture, and risks the film being scratched in the course of the frequent wiping which is necessary. If glycerine be mixed with the water, from ten to thirty prints can be made after each time of damping. To

prepare a plate for printing it is first of all carefully cleaned at the back from any adherent gelatine, &c., then placed on a levelling stand. The surface is now covered with sufficient of the following etcher :

Glycerine	5 ounces
Water	15 ounces

This is allowed to remain upon the film for about half an hour, after which the etcher is soaked up with a sponge, and returned to the bottle or jar. A sheet of clean blotting or other white paper having been put on the bed of the press, the plate is laid upon it, and with a soft cloth the surface is carefully dabbed dry.

While the plate is etching, the roller should be scraped, the inking slabs cleaned with turpentine and a rag, the composition roller washed with turpentine, the ink mixed, and the leather roller charged with ink. When the plate has been laid on the press, and the surface been dabbed dry, the leather roller is at once passed over, and after a few seconds the image will take ink, and gradually gain in brilliancy. Roll carefully until the image is perfect in its details ; lay down the leather roller, pass the composition roller over the inking slab, then over the plate. This will clear up the image, and smooth down any irregularity left by the rougher leather roller ; now take a print, being careful not to use too great a pressure, as the glass plate is easily broken.

The first print is seldom entirely satisfactory. If the image is mottled, the pressure has not been sufficient, and for the next print must be made heavier, this being done in lithographic and collographic presses by means of the screw on the head above the scraper ; on a typographic press, by means of a screw above the platen or the lever. If the whites are degraded, the ink is too thin ; in this case the leather roller must be scraped, the slab cleaned, and the ink made stiffer by the addition of fresh ink from the tin, which must be well worked up with the palette knife. If the half-tones are blocked, wash out the ink with turpentine, cleaning this off with water ; then add a little ammonia to the etcher (say one dram to the 20 ounces), cover the film with this, and allow to act for fifteen minutes, then soak off, dab dry, and ink up again. When ready for printing, ink up the image roughly, put on the mask frame, run the fingers

round the margin of picture, so as to get an impression of image upon the parchment paper, of the exact outline. Now remove the mask, and with a straight edge and a sharp knife, cut out an opening in the parchment paper, about $\frac{1}{16}$ of an inch larger all round than the picture; now take a sheet of the paper to be printed upon, and measure it carefully, so as to get the image in the centre, and mark on the outside of the mask thus ⌐ ¬ with lead pencil. These marks are to show where the paper has to be laid in order to get the image in the centre of the paper each time.

The cutting out the mask should be done on a sheet of glass, or on smooth metal, as any punctures, or tearing of the opening will spoil that mask.

Dirty margins can be remedied by painting over with a weak solution of oxgall, or of caustic potash, but in hand-printing from carefully-prepared plates, these dodges are seldom necessary. If the collotype plate be allowed to get damp at any time between drying, and washing out the bichromate, the margins are apt to print dirty, and the whites also be degraded; then the use of oxgall will be necessary, and probably also the caustic potash, but the best plan is to rely upon the addition of ammonia to the etching solution to obtain the requisite brightness, and if this, after a prolonged soaking, is not sufficient, it is advisable to try another plate, and take more care over its manipulation. Damp is about the only thing a collotype plate is spoilt by, if the formula as given is properly carried out.

When a plate refuses to take ink at all, it has had too long an etch, and should be either allowed to stand a short time, or else one or two dummy prints be made, so as to soak up a little of the moisture standing on the plate, the latter being the best remedy for over-etching. The portions of the image that take ink too freely for pictorial effect, should be etched by themselves, either by painting over the etcher with a brush, or blowing with a pointed glass tube. In fact, a careful printer can, by the exercise of judgment, obtain good results from any kind of plate.

When the plate is in good working order, it is inked up after every impression until a slight deterioration of the whites is observed. Then it is covered with the etcher for a few minutes; this is soaked off with a sponge, the surface dabbed dry with a

cloth, and the printing resumed. At first this will be required after each ten or twelve prints, but afterwards, as the surface gets softer, as many as twenty or thirty may be made between each etching.

On the hand press about 500 prints will be the maximum number that a plate will yield, and as the trouble involved in making a fresh plate is so small, it is not worth while to produce indifferent prints from a worn-out plate, but to have a fresh one each day.

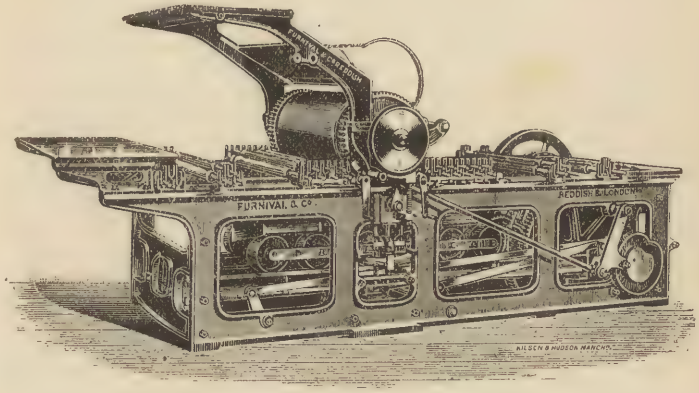
If the film comes away from the plate during the operation of rolling up, the substratum is at fault, or the plate has not been clean, or the substratum was rinsed before being quite dry, or the proportion of silicate of soda in the beer is not sufficient. Too great attention cannot be paid to the substratum stage, as unless this is all right the film is sure to come away when being printed from.

If the prints have a mottled appearance in the whites and half tones the coating of gelatine is much too thick; the film is also too thick if an inordinate amount of pressure is requisite in order to get the ink out of the deepest black. The first fault cannot be remedied in that plate, but the last will disappear after a few pulls.

CHAPTER VI.

PRINTING FROM COLLOTYPE PLATE ON MACHINE.

The Machine.—A collotype machine is an elaborated lithographic machine, being fitted with two sets of inking rollers—one set of leather behind the cylinder, and a set of gelatine in front. There are no rollers for damping, this operation being



COLLOTYPE MACHINE.

effected by an occasional stoppage of the machine, when the plate is damped, or etched, by being covered with a mixture of glycerine, water and ammonia.

A collotype machine is usually fitted with a mask frame, but it is very seldom used nowadays, as a skilful printer can, *when*

he has a good plate, so adjust his backing-sheet as to ensure clean margins without any mask.

A few years ago none but foreign collotype machines were to be had, but now there are several English firms who supply them.

Etching the Plate.—Before the collotype plate can be put on the machine it must be etched. To do this, place the plate upon a levelling stand, and cover all over with the following solution:

Glycerine	1 ounce.
Water	5 ounces.
Ammonia	from 1 ounce to 5 ounces, according to plate.

The glycerine and water soaks into the film, and enables the whites to reject the ink. The ammonia opens out the grain in the shadows, and must be used in greater or less proportions, according as the shadows are hard or soft.

Making-Ready.—The glass plates for printing at machine may be bevelled or not.

The preparation of the plates is exactly the same as for hand press, but the image is exposed on the edge of the plate about 1 inch or 1½ inches, or thereabouts, according to circumstances. If the job is to be printed on paper with a broad margin, the picture may be still further on the plate. The object of this is to keep the grippers from striking the edge of the plate, although on a good machine, providing the backing-sheet is of the correct thickness, the grippers may roll over the plates without danger of breakage. This is arranged by the grippers working on a bevel on the edge of the cylinder, thus bringing them below its circumference.

Presuming that a plate is ready etched for printing on machine, the first proceeding is to make the backing-sheet. Several pieces of thick or thin blotting-paper are taken, of the required thickness, gummed together along one edge, and feather-edged. The size of the picture about to be printed is measured off from side to side, allowing one-eighth of an inch more at each side; then mark off from front to back, and allow an inch or so larger—*i.e.*, supposing the picture to be 11 × 9, the backing-sheet would be 11¼ × 10. Bevel the edges all round, and the backing-sheet is complete.

At some houses the preparations are of such a sticky nature that it is necessary to make the backing-sheet the exact size of the work.

In either case, the backing-sheet is stuck on the cylinder with glue or dextrine, and the distance from gripper-lays to base-line of work carefully measured to correspond with the exact margin required on the prints.

The blanket—which is usually either glazed waterproof or rubber—is now adjusted and fastened up, and the cylinder is complete.

Assuming that the machine has been washed up, the rollers and riders are placed in position, ink is applied to the duct-roller, and the machine is run to distribute it thoroughly on the rollers and tables for a few minutes. The bed is next carefully cleaned, and a piece of white paper placed in position on the bed against the ledge provided.

Now carefully clean the back of the plate, and place it on the white paper. Then fasten with the screws and plates provided.

A gripper-gauge is provided with every machine, and it is placed from side to side of the machine, resting on the racks. One of the teeth on each side will be found marked to correspond with the grippers, the gauge being adjusted to these; and the distance from it to the base-line of work is measured the same distance as the backing-sheet was from the gripper. This is done by moving the bed by means of the screws provided for that purpose.

The same gauge on both English and German machines is also used to adjust the pressure. For this purpose it is placed on edge across the centre of the plate, and rested on the racks at the sides. The bed is then raised or lowered, until, by testing with a piece of paper, the plate just touches the gauge, and is fairly level. It will, however, be found that this is not sufficiently high to correspond with the cylinder printing circumference. It is only a safeguard in making ready when changing plates of different thicknesses. A cylinder guage is now supplied for the height of packing on the cylinder.

Now, after seeing that all is clear and everything is in correct position (no spanners on the bed and your whiskers out of the way) the word is given to the layer-on to start the machine;

this he does after placing in the grippers a piece of white paper the size of job. When the cylinder has made one revolution the machine is stopped, and on examination it will be found that there is no impression. So a turn of the pressure wheels at end of machine will be necessary and must be repeated after every trial revolution of the cylinder until the work is sharp from end to end and the impression solid.

If the plate is etched enough the job may now be proceeded with, and if any trouble is experienced in keeping the gripper edge and margin clean it may be treated with ox-gall, or a weak solution of cyanide of potassium.

But if the preparation is of the best no trouble is experienced in this way; and consequently, with the backing-sheet carefully made, no mask or frisket of any kind is required on the cylinder. With some preparations it is impossible to work without one, and for this purpose it is usual for the machine to be supplied with a circular frame, which fits in grooves round the cylinder. Two strips of zinc are fastened from side to side and two from front to back, this forms a square in the centre, which can be adjusted nearly to the size of work and feather-edged with tracing paper more exactly. The backing-sheet will also have to be cut the exact size of work.

It is usual to start the machine by mixing the ink rather stiff for the leather rollers, and mixing a little thinner for the gelatine rollers.

Good plates will work without any further application of thin ink to the gelatine rollers. It is only intended to give them a start as they take a lot from the other slab.

The plate is etched and damped with a mixture of glycerine and water and ammonia of varied proportions according to circumstances.

Normal mixture:—Equal parts of glycerine and water and one-tenth part of ammonia.

Part VI.

TRICHROMATIC PHOTOGRAPHY.

CHEAPSIDE.

[From plates lent by the Arthur Cox Illustrating Co., Birmingham.]

CHAPTER I.

TRICHROMATIC PHOTOGRAPHY.

TRICHROMATIC photography is the term applied to the production of photographic negatives from which coloured prints—either by means of half-tone blocks, collotype plates, or photo-lithography—are produced in three workings, the preparation of the selective negatives being in each case the same.

This process consists in making from nature, or from a painting, a series of three negatives. In one negative (the yellow), the blue and the red rays are non-existent; in another (the blue), the yellow and red are eliminated; and in the other (the red), the blue and yellow are missing. From these negatives either blocks, transfers, or collotype plates are made, each of which, when printed in its own colour of ink and superimposed, yields a print in colours and tones identical with the original.

The Camera and Stand.—In order to obtain these selective negatives, it will be necessary to provide certain apparatus. First, the camera must be a solid copying one, on a good heavy stand, capable of being fixed after focusing so that the three negatives can be made without fear of movement between any of them, as one focusing must do for all three, or true register cannot be expected.

The Lens.—In tricolour work the lens is an important factor. Some ordinary rectilinear lenses will answer every requirement, but not always. The newer lenses, such as Dallmeyer's Stigmatic, or Cooke's Process, are reliable, and will give good definition with any colour of screen.

The Colour Filters.—The use of these filters will be best understood if the student were to invest in a hollow prism.

First of all fill this with carbon bisulphide, and then by its means project the spectrum upon a white sheet, using either sun or artificial light for the purpose. Now, having coated a few glass plates with collodion dyed with various aniline dyes, interpose these dyed plates and observe the effect. For instance, with a yellow screen the blue and red rays of the spectrum are cut off; with a blue screen, the red and yellow; and with a red screen the blue and yellow rays are missing. An hour spent with the prism and the coloured screens will teach more than any amount of reading about them.

The colours most useful will be methyll violet (red shade), Hoffman's violet, malachite green, napthaline red, eosine blue, chrysoidine, fluorescene, aurine, and methyll orange. These colours can be mixed with plain collodion just short of saturation point—*i.e.*, as strong a solution of the dye in the collodion as is possible—without the film drying opaque. For making the screens, sheets of thin patent plate will be required, quite free from air bells or scratches. The screens may be placed either close up to the lens (in which case they need only be a little larger than the back lens), or close up to the sensitive plate, then the screen must be as large as the sensitive plate: these screens may be single plates just coated with the dyed collodion, or of two plates cemented together with the dyed collodion film in between. The single plates are the best, as the dye in time gets lighter, and very often changes in colour; a change, however, which can only be detected by examination in the spectroscope. A single set of three screens is not of much use, especially for the yellow and blue plates. because all coloured objects are not alike; therefore, to be ready to reproduce every subject, it will be necessary to be able to modify the screen to suit a particular picture.

Glass tanks in which a coloured solution is placed are sometimes recommended, but there is an objection to their use. It is not so easy to add to or take from their cutting-off powers, as it is when glass plates are used.

Negative No. 1.—This is the yellow plate, which is that part of the picture required to be printed in yellow ink. To make this negative, the choice of the following screens can be made, viz.:—napthaline red, methyll violet, or Hoffman's violet. The exposure must be made to suit the reds in picture and get

them over-exposed. If the reds are dark and the yellows light, an ordinary plate may be best, but as a rule a process plate is recommended. Develop with pyro soda in all cases for the three negatives.

Negative No. 2.—This is the red plate—*i.e.*, that part of the picture to be printed in red ink, the blue and yellow being obliterated by over-exposure. The screen for this plate is green, the sensitive plate to be used being an Ilford chromatic, or a Lumiere's A plate.

Negative No. 3 (THE BLUE IMAGE).—In making this the red and yellow are to be got rid of. The screen for this plate is yellow, and the choice of dye lies amongst eosine blue, chrysoidine, fluorescene, aurine, and methyll orange, either separately or combined with another, the sensitive plate used being a Lumiere's B plate, and in some cases a C plate. The relative exposures cannot be given with any degree of exactitude, as each set, and often each colour, will differ from any other, but as a guide the following set of exposures on a bunch of flowers will be instructive.

PLATE No. 1, stop F-16., the yellow plate. Screen napthaline red, Ilford half-tone plate, exposure in a well-lighted studio one minute.

PLATE No. 2, the red plate. Green screen, Ilford chromatic plate, exposure half a minute.

PLATE No. 3, the blue plate. Screen fluorescene, Ilford chromatic plate, exposure two minutes; same screen, but a Lumiere's A plate, one and a half minutes will be sufficient.

Half-tone Colour Blocks.—When the selective negatives have been obtained, contact transparencies must be made (paper prints cannot be used on account of the impossibility of ensuring each print being accurate in size), using for this purpose any good ordinary process plate, developing with pyro soda, and from these transparencies the grained negatives are made, either in a daylight enlarging camera, or in an enlarging lantern. In either case the greatest care must be taken, otherwise correct register with the blocks will be impossible.

A single lined screen is the best to use. In the yellow plate the lines running, say, from left to right, diagonally; in the red, from right to left; and in the ~~red~~ blue, vertically; the negatives being made in a three-way carrier. If a single line

screen be not available, single-line effect can be obtained from a double-line screen, by using a diaphragm with a slit running parallel with the lines of screen.

The grained negatives being obtained, the blocks are made as described in Part III.

For Collotype.—The selective negatives are made with a prism or mirror, and are used to produce the collotype blocks from which the prints are made. It will be absolutely necessary to have a set of leather rollers for each colour ink, as the inks used in three-colour printing are too delicate to admit of being worked off with anything but a clean roller. The machine used must have perfect register, so as to get absolute superposition of each colour.

For Photo-Litho.—There are two ways of producing these selective negatives for photo-litho. One method is by making them the same as those used for half-tone blocks (except that they must not be reversed). Then, from the grained negatives, make transfers as described in Appendix—*i.e.*, on gelatine coated paper, dried on glass after sensitising.

Another method is to make the selective negatives as for collotype, with a prism or mirror, keeping the negatives rather flat than vigorous; and then, from these negatives, print upon collographic plates prepared as described in Part IV., chapter vii., page 117, *et seq*. The resulting transfers are put down upon stone, and give very fine colour results, provided the transfers are not hurried in the first instances. The grain obtained from a collographic plate is very suitable for true chromatic printing, and a lithographic artist will be able to strengthen or soften the pictures when required, and so obtain better results than by any other method.

CHAPTER II.

*PHOTOCHROMIC PRINTING INKS.**

So much depends on the inks used in photochromic work, that we think this chapter will not come amiss to those of our readers who have to pull proofs of their own work, or who have to give advice to their customers as to the kind of ink to be used.

Although the photochromic three-colour process is adaptable to collotype and lithography, as well as to letterpress, yet, for commercial purposes, at the present time, the half-tone block reigns supreme. And although collotype—as in the monochrome, or ordinary, method—gives the most delicate results in three-colour work, yet it is, at the same time, the most difficult and expensive to work. Therefore we will confine our remarks to the inks used for half-tone plates, although what holds good for these will also hold good in a general way for the two sister processes.

For half-tone work only the very best inks should be used. The blocks, on account of their flat surface, take very little ink in comparison with woodcuts or type, and therefore, unless the ink is made of strong pigments of the finest quality, the prints will turn out flat and look washed out.

One of the crucial tests of good photochromic work is the production not only of a correct rendering of the colouring of the original, but the production of neutral blacks and greys wherever they occur, be it a painting or still-life object. If the colour-filters are correct representatives of the primary colour-sensations of the spectrum, the resultant negatives will be monochrome representatives of the respective primary colour sensations reflected from the object. It is necessary in order

* We are indebted to Mr. C. G. Zander's book on "Photo-Trichromatic Printing," for the information contained in this chapter.

to obtain a correct rendering that the blocks should be printed in inks which are complementary colours of the colour-filters used. It is obvious, therefore, that as the colours of the three selective screens, if scientifically constructed, are—if we may use the term—a fixture, so the three pigmentary colours used in printing are also a fixture, and cannot be arbitrarily selected. The three pigments which alone produce a correct colouring of a picture produced by the photochromic process, are a pure red pigment, one that is neither a purple nor an orange, but is the primary red of the artist—*i.e.*, the combination of fundamental red and blue-violet of the spectrum. The yellow ink must be a pure yellow not inclined either to orange or green—*i.e.*, about the shade of sulphur, or what artists' colourmen call "lemon yellow." The third ink, the blue, must be cyan-blue, somewhat similar to a greenish cobalt blue. Neither the violet nor the green should, however, preponderate in this blue. If these three inks are correctly made, it will, by their mixture, be possible to produce every colour, including tints, saddened hues, and dense blacks. Some ink makers unscrupulously use fugitive aniline lakes for the red, which, after a few days' exposure to light, will fade and render the colouring of the whole picture incorrect. As permanency is desired, alizarine lakes, made of alizarine, which, like aniline, is a coal-tar product, should be employed. It is also found in nature as the colouring principle of madder root, which used to be extremely cultivated in the South of France. Modern artificial madders are perfectly permanent, and can be produced in all shades of red, from scarlet to purple, and in excellent imitations of carmine and cochineal crimson, and scarlet lakes.

Ultramarine is a most undesirable pigment for half-tone photochromic inks, on account of its opacity and because it does not print flat.

In a photochromic picture, the various colours are produced by the superposition of yellow, blue, and red dots of various sizes. Where these dots cover each other they produce a pigmentary mixture, almost identically as if the pigments had been mixed by a palette knife previous to being printed. Where these dots lie next to each other they produce an optical mixture—that is, the eye will record two adjoining dots simultaneously. For instance, red and blue appear as violet; blue and

yellow as green ; red, yellow, and blue—*i.e.*, the three colours combined—as black (or grey if the dots are small and allow the paper to reflect white light through between the interstices).

These remarks now lead us to the second essential quality of the photochromic inks—*viz.*, transparency. Unless the pigments used are transparent, the pigmentary mixture just alluded to cannot take place. Wherever, for instance, an opaque red dot should cover a yellow one, instead of producing an orange or scarlet it would only show the colour last printed, but if the red is transparent it will combine with the yellow to form orange. It is not very difficult to find a red that answers not only to the required shade, but possesses transparency; we find it in madder lake, struck on a transparent base, such as hydrate of alumina. This pigment possesses another valuable property, that of absolute permanency when exposed to sunlight. The blue pigment is more difficult to produce. The best is a cyanide blue, which can be made of the requisite shade, and is transparent. It cannot be called absolutely permanent, but the fading when printed full strength is so slight that it need not be taken into consideration. Artists do not hesitate to use this blue in the most valuable pictures. Ultramarine must be rejected on account of the reasons already mentioned, and aniline blues are much too fugitive. The most serious difficulty presents itself in the selection of the yellow. Up to now the non-success of producing an absolutely permanent transparent yellow necessitates the use of an opaque pigment and printing the yellow first. If this is done it does not matter if an opaque yellow pigment is used so long as it is permanent, and of the requisite shade. It is also advisable to print the blue last, on account of its possessing the smallest luminosity. But for these two reasons, it would not matter in what order the colours are printed. So it is necessary to print them in the order of yellow, red, and blue.

It need hardly be mentioned that it is of great importance that the pigments should be well proportioned as regards their colouring power. If that is not so, it will be found that the strongest pigment causes the picture to be coloured with a preponderance of that particular colour, which is generally the red. Placed in Lovibond's tintometer, it will be found that the yellow and blue pigments are of about equal strength (about seventeen

units each), whilst the red pigment, if madder, will measure probably thirty-four units, or about double the strength. It is, therefore, necessary the printing ink maker should proportion the strength of the pigments if correct colouring of the picture is to be expected.

Use good paper only, hard, well-sized, and glazed, and in printing use hard packing, eight or ten sheets of cream wove paper. It will then not be difficult to print from blocks of very fine grain, and the colours will appear much cleaner and brighter. No pains should be spared, either, in the making ready of the blocks.

Appendix.

APPENDIX.

Strengthening Image on Zinc Plate.—There are several methods of proceeding with the preparation of the image on the zinc plate previous to etching. On page 69, directions are given for strengthening the image by rolling up—*à la* lithography—with ink. Nowadays, to a very great extent, this rolling up previous to the first etch is dispensed with, and the ink image reinforced with finely powdered resin, which being melted and incorporated with the ink image forms a better resistance than the old method, and at the same time yields a finer line, without any danger of thickening, which is always present in the rolling up system.

Calmel's Powder.—This is a special dusting powder introduced by Mr. H. Calmel, and is manufactured by Penrose and Co. To use it, and prepare for etching prints on zinc, either in inked up albumen or transferred to zinc in litho press, apply the powder with a soft brush, taking care that every part of the image has its share of it, then brush away all traces of the powder from the whites, and put plate on hot-plate until the powder melts. Allow to cool and the plate is now ready for the first etch, which is carried to such a depth as to give a good line. This will occupy about five minutes in an acid bath of the strength given on page 70. After etching as above, gum in, roll up with soft etching ink, dust with powdered resin, and then proceed as described on page 70 *et seq.*

Russell Powder.—The following is a very good method in the hands of an expert etcher, but is scarcely likely to be very successful unless the operator knows what he is aiming at. The materials required are white powder, Russell powder, and prepared dragons' blood. The image is printed as usual in

bichromated albumen, inked up, developed, and dried. When dry, brush the white powder over the image, using a pad of lint or cotton wool; follow this with the Russell powder, removing the surplus with a soft brush. Give the first etch in a bath of water, 80 ounces, nitric acid, 1 ounce, and etch only deep enough for the finest dots. Then wash and dry with chamois leather, slightly damp. Heat on hot-plate, paint the back and margins of plate with varnish, add ½ ounce more acid to the etching bath and give a good etch; remove, wash, dry, and heat the plate gently, so as to soften the resin in lines, and then brush over with dragons' blood, brushing all four ways across the plate—by the means of the dragons' blood, the powder adheres to the tops of the lines and also to the sides. Heat again, and when the plate is cool enough not to melt the resin, brush over the dragons' blood the four ways again, repeating the operation, if necessary, until the sides of the lines, made bare by the acid, are covered with a coating of melted dragons' blood. Etch again, and repeat the operations, until sufficient depth is attained, then clean off resist, ink up with glazed roller charged with hard etching ink, and give the finishing etch as usual.

The above constitutes all the methods that are any improvement on those originally published in 1886, and no more need be written, except this:—there are in the market many tools for helping the etcher in the form of routers, saws and planes for cutting up and mounting the etched plates, but the reader is referred to the dealers' catalogue, or better still, to a visit to one of the establishments which cater specially for the process worker, when more information can be obtained than in pages of reading.

Prints for Copying.—Good glazed silver prints are amongst the best from which to make grained negatives; matt silver comes next, but it is more difficult to get a firm dot in shadows when a matt surface is copied, because some of the light is absorbed instead of being reflected; matt bromide and platinotypes, unless of really first-class quality, are also troublesome, although when the originals are to be touched up, they are easier for the artist to work upon. In cases where the operator has the negative sent to him instead of a print, an enamel bromide developed with amidol, will be quickly finished, and

yields better results than a glazed silver print, because the shadows are a blue-black instead of red.

A New Screen has just been introduced, consisting of sets of four lines running in four different directions, so related and proportioned as to form groups of transparent apertures as well as of opaque intersections. The fine results from this screen, in addition to the number of minor varieties of texture, are due to two essentially different dots, both in lights and shadows, of such proportion to each other, that in the higher lights and deepest shadows, respectively, the smallest dot of each group is automatically closed up.

Although the preparation of these screens presents many difficulties, the extra price is not prohibitive, and the results are different to those produced by the ordinary two-line screen. The blocks are easier to print from, and once the initial difficulties of making the negative are overcome, the operator will find his results much better.

Printing on Zinc.—The image can be put on the metal by the bichromated albumen process, dusting the image with white powder, followed by Russell powder and dragons' blood; or the ink image may be dusted with dragons' blood, the plate being heated (after the surplus powder is brushed off) and then etched. The bitumen process is not quite dead, it being still in use, principally because it is possible with it to print a number of pictures on one plate, thus saving time and metal. In this case the negatives are made by the wet collodion process without a mirror, the negative, when dry, being coated with a thin solution of india-rubber in benzole; this being set, it is covered with plain collodion and dried, then an immersion in a weak acid (sulphuric) bath allows the film to be lifted off the plate, and after a short stay between sheets of clean blotting paper, the film is, by means of a roller squeegee, pressed in contact with the film of bitumen spread upon a sheet of zinc large enough to take the six, eight, or more films, necessary to fill the sheet.

Transfer Papers.—Husnik's photo-lithographic transfer paper has been superseded by Jaafe's Eagle Brilliant. The great drawback to all paper methods of photo-litho transfers is the unequal stretching of the paper used—*e.g.*, paper that stretches ⅛ of an inch lengthways, will stretch ⅜ inch or more the other

way. This can be obviated by drying the paper on glass previously polished with French chalk and vaseline, or wax in benzole. However, a modification of the sensitising solution is necessary, because the ordinary solution is not sufficiently strong to give a good transfer.

The following is the method of procedure :—The glass plate must be a little larger than the sheet of paper. For Eagle paper, measuring 25 × 20, the glass plate (¼ or ⅛ inch, British plate, free from scratches) should be 26 × 21. This is cleaned thoroughly, and then polished with vaseline or wax dissolved in benzole ; this is smeared on the plate, well rubbed in, and polished off, until no trace of it can be seen ; follow this with French chalk, which is also polished off thoroughly ; in doing this be sure that the edges are polished, or the paper will stick.

The sensitising solution is a saturated solution of bichromate of potash, to every 40 ounces of which 1 ounce of ferricyanide of potassium is added. The gelatine-coated paper, Autotype Company's or Jaafe's Eagle Brand, &c., is soaked in this solution until quite limp, when it is lifted out, drained, and laid face down upon the chalked glass plate ; the back is then squeegeed lightly and wiped with a cloth, so as to equalise the moisture. Now dry in the dark, either in the drying oven at 60° F., or in a warm draught ; when dry the paper will strip off, possessing a beautiful gloss, and giving every facility for perfect contact with negative during exposure in the printing frame. The method of inking up the transfer is that given on page 105 ; follow that method carefully, and note what is said on the same page *re* quantity of ink put on, as in this item lies most of the success of a photo-litho transfer. By squeegeeing the transfer paper and drying it upon glass, when the transfer is damped ready for the stone, the image will be the exact size of image on the negative ; hence, care must be taken that the exact size of job is obtained on the focussing screen, and that no allowance (by the ordinary method so necessary) be made for the stretching of the paper.

Clarified Glue.—For the enamel process, the principal ingredient is a glue soluble in cold water, and as the glue on the market is variable in its quality, a knowledge of how to prepare a suitable glue will be useful. Any ordinary glue, if

dissolved in water and mixed with bichromate, will give a good image on the metal, but the film will be full of pits, and portions with no image at all; this is because the glue is tainted with grease, and until that is got rid of it will be impossible to obtain an even film on the metal. The operation of getting rid of this grease is a clarifying one, and is carried out as follows :—1 lb. of common glue is broken into small pieces and soaked in sufficient cold water (frequently changed) to cover it until quite soft right through; then add the whites of four eggs (fresh out of the shell) and five ounces of ammonia; mix the lot with a stirring rod, place the jar containing the above mixture in a pan of strong brine; place on a gas stove and gradually bring up to boiling point, and continue until the albumen is coagulated; then strain the glue through a coarse cloth and allow to cool. When cold, the clarified glue can be used in the same way as fish glue. It is impossible to give an exact formula, because the glue may vary so much; but a trial will soon show what is the proper proportion. Clarified glue prepared as above is often mixed with fish glue, and is especially useful for printing upon zinc, as it carbonises at a much lower temperature than does fish glue.

Posters by Photography.—It is not everyone who has a large screen and camera, &c., necessary for the production of large half-tone pictures suitable for posters. However, a little consideration will show that large engravings can be done better by enlargement from a good small negative made with a fine screen, which will preserve detail better than a coarse screen would. This method of working will require certain precautions and suitable apparatus. First of all we will trace the method from beginning to end, commencing with the small negative. This must be perfect, and should not exceed $8\frac{1}{2} \times 6\frac{1}{2}$, made with a 135 screen, and from this negative a transparency must be made by contact in the camera. Thus :—carefully clean the back of negative and dust over the film; lay it face up in the carrier of dark slide, and on this (film down) lay a process dry plate; close up the dark slide and insert it in its place in camera. In front of the lens have a large sheet of white paper, and in the lens stop F-16 or 32. Make the exposure and develop with the usual developer, but add ten per cent. more bromide. The transparency must be perfect, the dots on high

lights sharp and solid, the holes in shadows *perfectly* transparent; this transparency is now placed in an enlarging apparatus, which may be either for use with daylight or with artificial light, but in either case the most perfect parallelism must exist between transparency, lens, and sensitive plate. If artificial light is to be used, then a condenser will be necessary, and between the light—which may be an oil lamp, the electric arc (hand-fed, not automatic) or lime-light—and condenser, a sheet of fine ground glass must be placed in order to get a perfectly even illumination, which is impossible without. The lens must be capable of covering a plate at least a size larger than the transparency—*i.e.*, suppose the image on transparency measures 6 × 4, then a lens capable of covering a plate 8 × 6 must be used (*but the lens must not be a wide angle*); lenses of the stigmatic type or Cooke's Process Lenses will be found best. If a lens of too short a focus be used, the dots at edges of plate will be oval instead of round, and the effect of gross distortion given; hence the necessity of using a longer focus lens than usual. For the enlarged negative, either a dry plate (process) or wet collodion can be used, and, if due care be taken of the exposure and development, no clearing will be required, as this negative is practically a line negative. For printing on the zinc no different procedure than that already described in Part II., chapter III. is necessary, nor will the etching be different to that for ordinary fine line work. These enlarged grained negatives can also be utilised for making photo-litho transfers, the method recommended being that described in this Appendix.

Diaphragms.—There is a great deal of difference of opinion as to which is the best form of stop or diaphragm—the round, the square, (with or without the extensions at the corners), the elliptical, or the cushion shaped. Good work can be done with each shape, as it is not exactly the shape of stop that does the work, but the operator, and, like every process in photography, a method working well with one operator, is a failure with another. Instead of depending upon the exposure and a carefully chosen stop to obtain a good dot in the shadows, some operators use a sheet of white card in front of the lens during some part of the exposure. This shortens the exposure, but if used locally, the white card being cut to shape and size of tends to give flat results.

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